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FUTURE MEETINGS: The University of Texas, Austin, Texas, March 31-April 2, 1961; U. S. National Museum, Washington, D. C., June, 1962; The University of British Columbia, Vancouver, B. C., June, 1963.

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On the Mating and Egg-laying Behavior of the Surinam Toad, *Pipa pipa*

GEORGE B. RABB AND MARY S. RABB

IN an earlier paper (Rabb and Snedigar, 1960) some features of reproduction and development in the Surinam toad (*Pipa pipa*) were described as observed in captive animals at the Chicago Zoological Park during the spring of 1959. The same pair bred again during the night of March 2–3, 1960, under the conditions previously detailed. This time we were able to observe and photograph the oviposition, which has long been a mystery and a subject for speculation.

As before, the preliminary amplexus was prolonged for at least 24 and possibly as long as 30 hours. In amplexus the male clasped the female about the lower abdomen firmly with his forearms, with his wrists burrowed into her belly (the fingers were turned out) and his chest pressed down on her back (Fig. 1, top). During this period there was a noticeable tumescent build-up of the female's back skin and the lips of her vent swelled considerably. For the most part the animals were quiescent, but they ascended for air periodically, at which times the male relaxed his grip in order to slip forward and get air as she did. Several times the female was the only one that succeeded in getting air when they surfaced. The male occasionally made a pumping action involving a tightening of the forearms and a staccato up and down movement of his head. This action was reflected in tremulous movement of the dorsolateral skin surrounding the lungs and of the feet, particularly the webbing.

About three hours before the first egg was laid the female struggled against the male's grip, whereupon he loosened his hold somewhat. A half hour later this was repeated. After some following readjustments in their position it was observed that the dorsal part of the female's vent was adpressed to the anterior abdomen of the male (Fig. 1, bottom). The male's chin was now pressed firmly against the swelling skin of the female's back. The female then struggled against his hold and they went up part way in the tank as if for air. This time the male's grip remained tight as they ascended and they did a complete turnover without breaking the water surface. The ascent in the turnover was rotation about the longitudinal axis and in the descent they rotated transversely. An hour later, after more struggling and a turnover, the lips of the female's vent were observed to push in and out. After the fifth such turnover they descended head downward into a tilted position—her legs at a 30° angle with the tank bottom and the rear end of her body thereby elevated at about the same angle from the bottom, with the swollen vent pressed against the male's abdomen. In the next hour three more turnovers were observed, all ending in this tilted position. After the ninth turnover an egg was seen on the female's back just anterior to the vent. No egg was laid on the next turnover, but in the 16 subsequent turnovers laying was observed.

The action in each egg-laying turnover was instigated by the female, and consisted of a sideways upward movement, a momentary pause in a horizontally upside-down position, and a head-first return to the tilted resting position described above (Fig. 2). During the ascent, the male held her with a firm grip and his fingers, excepting the two distal phalanges, kneaded her abdomen (Fig. 2A). In the upside-down position the male's fingers continued to massage her abdomen and the female pushed her abdomen out with a contraction of the muscles (whether this effort was part of the laying or of the righting motion was not clear). In turning upside down both animals brought legs and feet toward their bodies with short swimming strokes. As she began to turn out of the upside-down position the male relaxed his fingers, raised his head a little, and floated slightly away from her, maintaining contact mostly with his forearms. In the beginning of the descent his head was returned briefly to her back and he brought his cloaca inward toward her back with a jerky motion. In this action his legs were extended (feet slightly anterior to her's) and his back strongly arched (Fig. 2C). Seven to nine in-

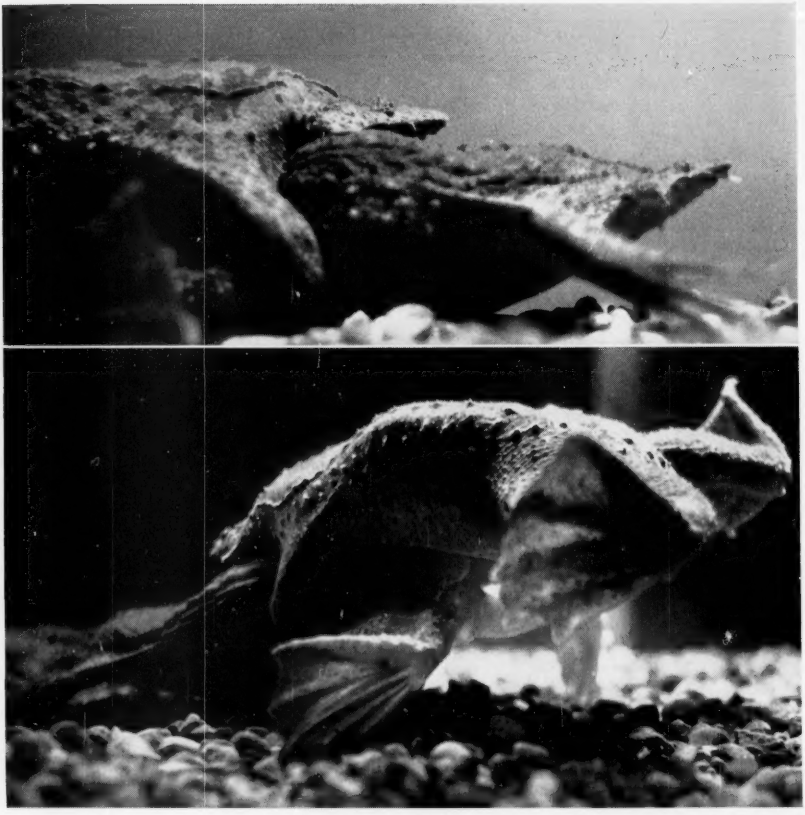

Fig. 1. Pre-oviposition amplexal positions of *Pipa pipa*. *Top*, amplexus position six hours before the first egg was laid. *Bottom*, horizontal floating position of the male within the hour before the first oviposition.

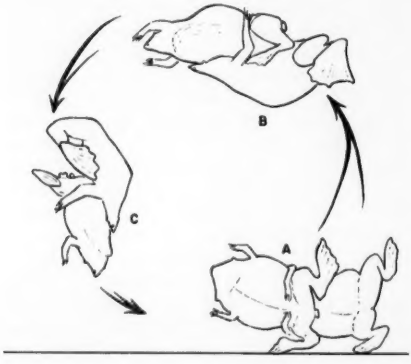

Fig. 2. The egg-laying turnover maneuver of *Pipa pipa*. A, beginning of the sideways ascent: the female has lifted her left side and is about to shove away from the tank bottom with her right hind foot. B, the momentary upside-down position in which the eggs are laid. C, the head-first descent to the tilted resting position. The ascending movement involves rotation about the longitudinal axis, and the descent is a half-roll about the transverse axis. Drawn from 16 mm. motion picture film.

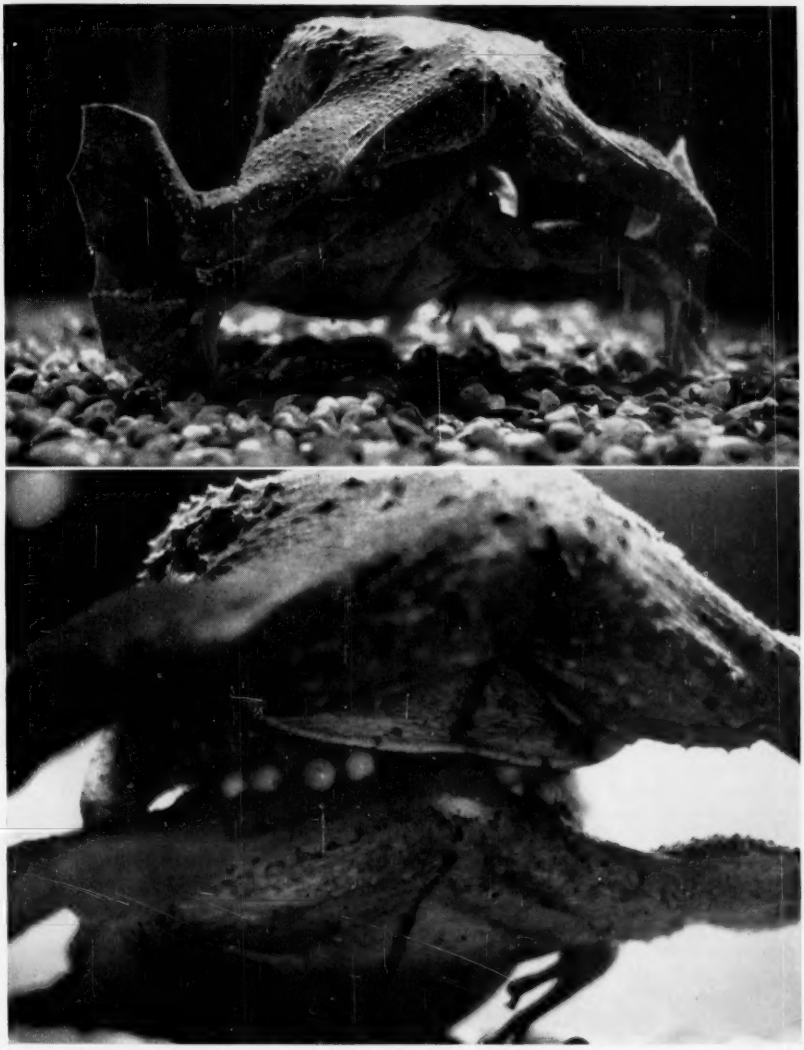

FIG. 3. The tilted resting position of *Pipa pipa* after an egg-laying turnover. *Top*, the position in relation to the tank bottom. *Bottom*, a close-up view of the posterior fold of the male's abdomen.

ward thrusts were made by the male as they came down, and counterbalancing strokes were made with his feet. She assumed the tilted position while he was making the thrusts, and he adopted a similar stance as the tank bottom was approached (Fig 3, top). The eggs were probably fertilized during his thrusts, and although we did not see any semen, it is very likely represented by cloudy discharges near his vent that appear in the motion picture film record during the thrusting sequences. The eggs were laid three to five at a time, usually at the midpoint of the turnover when the female was horizontally upside down. Eggs were more or less caught by the male's belly and its temporary anterior and posterior transverse skin folds. These folds apparently formed through the

arching of his body and the temporary adpressing of his head to her back during righting, and they seemed to prevent the eggs from rolling off his belly. In righting the eggs dropped onto her back and stuck there. The pressure of the male's clasp subsequently implanted a newly laid batch of eggs more firmly. Eggs that were laid before or after the momentary upside-down position fell to the bottom of the tank.

Following a laying they remained quite in the tilted position for from 5 to 10 minutes, the female's swollen vent pressed against the male's posterior fold of belly skin (Fig. 3). The fold was present as long as the male was arched. They usually ascended for air at the end of this period, coming down in the tank at the same angle as ascending and then remaining in a floating position parallel with the tank bottom (Fig. 1, bottom). The male's back was not arched in this resting position nor were abdominal folds present. However, the female kept her vent pressed to his abdomen.

Three turnovers of special importance in interpreting the fertilization stimulus are the one in which the first egg was laid and the ones immediately before and after. The one before the first laying was quickly accomplished and they descended to the tank bottom with the female's vent pressed against the male's abdomen. The male's grip was relaxed, but he made no signs of fertilization, only one stroke of his hind legs being involved in the settling process. He floated more or less horizontally above her as they came to rest (Fig. 1, bottom). In laying the first egg they made a very quick upward movement with the upside-down position lasting less than a second. The male began fertilizing actions slightly later than in subsequent turnovers, and their duration was shorter (about 2.4 seconds). During this first egg-laying turnover, the male arched his back and extended his legs in front of hers for the first time. The relative positions were maintained upon settling (Fig. 3, top). The turnover after this first laying was unusual in that no eggs were laid. After the upside-down position in this turnover they glided downwards in a position similar to the one described for the turnover before the first egg was laid. As in all the preliminary turnovers in which no eggs were laid, there were no fertilizing actions by the male.

Ordinarily an entire turnover sequence lasted 11 to 14 seconds. From 1 to 2 seconds were necessary for the turning ascent, they were upside down for about 1 second, and 7 to 10 seconds elapsed in the righting and settling down while the male was fertilizing the eggs; 6 to 7 of these seconds he was actively thrusting and balancing himself with flipping of his hind feet. During the oviposition period of three hours, an increase in restlessness was recorded between layings. The number of position shiftings and attempts at turning over increased. As many as nine false starts were made before a turnover was completed very late in the period. In the last hour the male began making a curious movement—a swing of his fully extended hind leg forward alongside her back. This usually occurred after the pair had been up for air or just before a laying. The action was recorded 11 times.

The first eggs were imbedded in the area near the vent. Later eggs were placed in the midbody region and two of the last eggs rolled forward toward the shoulder region. Fifty-five eggs were counted on her back at the conclusion of the laying. Eleven eggs were lost as they were laid and two were dislodged when the female rubbed her back against a water pipe in the tank.

After the last egg was laid they remained in the tilted position only about 2 seconds. In the 30 minutes that followed they were up for air three times and traveled about the tank shifting position and thrashing about. Once the male kicked his hind leg forward along her side. The female then began a quivering motion reflected in the waving of the webbing of her hind feet. She held her body stiffened in a slight dorsally concave arch, her forearms stretched straight forward, and her head pointed up. During the quivering, which occurred intermittently over a period of 7 minutes, he kicked his hind leg along her side twice, and there was considerable movement about the tank. They separated suddenly and he went up immediately for air.

The male then made a series of clicking noises. The interval between each click varied from 5 to 11 seconds, most of the intervals being 6 or 7 seconds, which is unlike the timing of ordinary clicking described by Rabb and Snedigar (1960:41). He made several attempts to clasp the female again, but she quivered when he touched her and swam across the tank.

Five minutes after the release we removed the male to another tank with four other females. Clasping was attempted with each of them and he continued slow clicking, but

all of the females reacted to his attempts at clasping with quivering similar to that described above.

While he was attempting to clasp the other females, the skin of his hind legs became loose and hung about them like ill-fitting stockings. The shedding proceeded over the entire body, and he ate the skin as fast as he could get it off in a grotesque sort of ballet.

Discussion and Remarks

We recognize the desirability of repeated observations on the remarkable oviposition process described above, and we hope to obtain more data. There is no reason, however, to suspect that the present case was abnormal in any respect. Except for initially greater loss of eggs, the development of the brood proceeded as in the successful breeding of the previous year. The loss of some eggs during the laying and possibly improper fertilization of some batches may have been in part a consequence of water currents caused by the rapid movements of the animals in the confines of the relatively small 70 liter aquarium.

In any event the foregoing account is at considerable and, we believe, correct variance with the story by Fermin (1765; *fide* Jameson, 1955) of the male placing the eggs on the female's back, and also with the report by Bartlett (1896) of the female using an ovipositor-like structure. As indicated by Rabb and Snedigar (1960:41), the latter was probably based on observation of a pathological condition.

In considering possible functions for some of the actions in the mating process in *Pipa pipa* we noted a number of parallels with the breeding behavior of other frogs. Since the literature is scattered and certain aspects have not received attention in recent reviews, it may be of interest to mention some of the more obvious points of resemblance.

The immediate stimulus for clasping in *Pipa pipa* is apparently simply the girth of the female. Our male often attempts clasping with the freshly fed or stouter females in the aquarium. Girth has been definitely established as a very important factor in the reaction in at least some other frogs (*e.g., Rana pipiens,* Noble and Aronson, 1942). Whether the clasp in *Pipa* is a necessary stimulus for the female's skin build-up or for ovulation we have not yet determined.

The pre-oviposition bobbing or pumping of the clasping male Surinam toad probably stimulates the female in ovulation. A similar action was mentioned for *Xenopus laevis* by Bles (1905), and Grimm (1952) and Russell (1954:122) have described it a little more fully. Russell stated that it consists of a low frequency tremor due to a sudden intensification of contraction of the musculature, particularly the *m. coracoradialis* and the snout depressors. Other presumably homologous pumping action has been noted in accounts of breeding of *Bombina variegata* (Savage, 1934) and of *Pelobates fuscus* (Eibl-Eibesfeldt, 1956).

The position assumed by the female *Pipa* late in the pre-oviposition period that results in the pressing of her swollen vent against the male's belly (Fig. 1, bottom) may correspond to the ready or "signal" position of other frogs (Eibl-Eibesfeldt, 1956; Aronson, 1943 a and b, 1944). If so, this belies Eibl-Eibesfeldt's implication that such action may not occur in the more primitive frogs.

The upside-down egg-laying process in *Pipa pipa* is unique among the anurans. The active kneading by the male might be expected among other frogs that have posterior amplexal grips, but we have found no such observation. The tilted position of the settled female is somewhat like the oviposition posture of *Gastrotheca* (Mertens, 1957). This position allows the eggs to roll forward on the female's back after dropping from the surface of the male's belly, as we definitely saw in the case of the two eggs that stuck near the shoulder. No gluey secretion could be discerned on the female's back although such might be suspected from descriptions of the gastrothecine and similar hylids (Mertens, 1957). The eggs at any rate have no sticking qualities of their own on other surfaces.

We believe that the sequence of turnovers at the beginning of egg laying rather definitely indicated that the extrusion of eggs is the stimulus for fertilization by the male Surinam toad. Similar circumstances are reported for *Xenopus* by Bles (1905), and *Rana temporaria* by Savage (1934), and perhaps *Pelobates fuscus* by Eibl-Eibesfeldt (1956).

The forward kick of the male *Pipa pipa* late in the oviposition period may be a stretching movement but more likely, in our opinion, it is an action compressing the female and stimulating her to complete the laying. A possible analogue is the "pre-release" motion of male *Rana pipiens* (Noble and Aronson, 1942).

The vibration and slight arching of the female *Pipa pipa* after the completion of laying is also used by non-breeding females

to effect release. The voice-possessing males click as well as quiver, at least when grasped with the hand. The same sorts of release mechanisms are known in several other frogs (Eibl-Eibesfeldt, 1952).

The post-release clicking of the male may well be classified as displacement behavior. It may not be so satisfactory to place the skin shedding at that time in this category, as Russell (1954:166) suggested for the post-mating shedding of *Xenopus* reported by Bles (1905). Perhaps this phenomenon is simply a result of high activity levels of the anterior pituitary during mating and not of a specific neurophysiological shunt.

Acknowledgements.—Thanks are extended to Robert Snedigar for help, encouragement, and the toads. We appreciate being given open access to the library facilities of the Chicago Natural History Museum and the University of Chicago.

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Chicago Zoological Park, Brookfield Illinois.

Effects of Pinealectomy in the Western Fence Lizard *Sceloporus occidentalis*

Robert C. Stebbins

Removal of the parietal eye in western fence lizards (*Sceloporus occidentalis*) in the Berkeley Hills, California, resulted in an increase in their frequency of detection and locomotor movements compared with sham-operated controls (Stebbins and Eakin, 1958). A potentiality for activity seemed to exist in the normal animals which in some way was held in check by the parietal eye. That sunlight may be the stimulus to the "eye" is suggested by its structure (Eakin and Westfall, 1959) and the results of shielding the organ with aluminum paint or foil. In *Sceloporus undulatus virgatus*, in the Chiricahua Mountains, Arizona, experiments in outdoor cages suggested that inhibition of

activity depended upon the stimulus of sunlight. When the "eye" was covered with aluminum foil or paint, exposure on the surface of the ground and to full sunlight increased over that of controls with foil placed behind the "eye." Under artificial light in the laboratory, increased locomotor activity occurred following aluminum foil shielding of the "eye" in yucca night lizards, *Xantusia vigilis* (Glaser, 1958).

Such hyperactivity following removal or shielding of the parietal eye, a part of the pineal mechanism in reptiles, is in accord with some of the results of experiments on pineal gland function in other animals. A number of studies have suggested that the pineal may have an inhibitory effect on target organs of the pituitary—the thyroid and adrenal glands, gonads, and melanophores—hence it has been thought that it may work in antagonism to the pituitary gland (Engel and Bergmann, 1952; Kitay and Altschule, 1954; Pflugfelder, 1957; and Thiéblot and Le Bars, 1955). The evidence, however, is equivocal.

The foregoing observations, along with morphological and embryological observations, have suggested the possibility of a functional relationship between parietal eye and pineal gland in fence lizards (Fig. 1, A). Perhaps the increased activity observed following parietalectomy resulted from reduced pineal function in the absence of sensory data received from the parietal eye. If so, one might expect that removal of the pineal, while at the same time leaving the "eye" intact, would give results similar to parietalectomy. The present paper represents an effort to test this idea.

Procedure

Pinealectomized and sham-operated fence lizards, permanently marked for future recognition by removal of toes, were released in the field a few days following surgery. Release occurred at original points of capture and subsequent behavior of the marked lizards was noted. The two surgical types were introduced in a 50–50 ratio, balanced as closely as possible as to size range and sex.

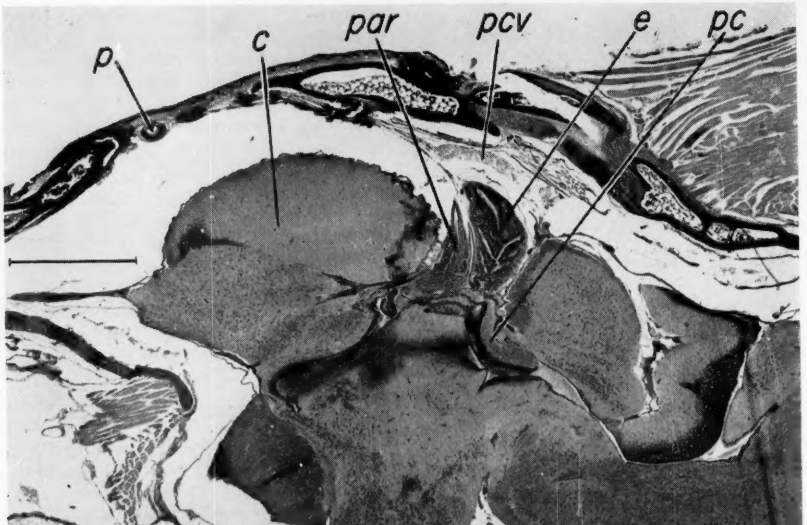
The area of study, at Big Springs Canyon, California, was the same as used previously (Stebbins and Eakin, 1958). It is a 10 acre tract of grassland and chaparral, at an elevation of 1300 to 1500 feet in the Berkeley Hills.

In the course of each visit to the study area an effort was made to determine the relative numbers of pinealectomized and sham-operated animals exposed on the surface of the ground. This was done by walking slowly along a predetermined route that ensured thorough coverage of the area. Only lizards abroad on the surface were recorded. In determining the score for the day each animal was counted only once even though it may have been seen more than one time.

The study was begun in mid-February, 1957, with the emergence of lizards from hibernation. At that time there were available for experimentation the half-grown young of the preceding summer and fall and a few unmarked adults. All other adults found were surgically treated, marked animals that had survived our earlier work. Of the 17 unmarked adults captured, 10 were males (55 mm. or more in snout-vent length) and the remainder were females (60 mm. or more in snout-vent length). The remaining animals were immature. By October 1, 1957, a total of 81 lizards had been pinealectomized and 75 had been sham-operated; all were newly captured animals. The ratio of marked to unmarked lizards shifted from 1 to 9, in the period mid-February to the end of March, to 5 to 1 in September.

Information on movements, growth, behavior, frequency and time of observation of the two surgical types, and body temperature was recorded. In view of earlier results special attention was given to distance and frequency of movements and to the amount and time of exposure on the surface of the ground and to sunlight. Body temperatures were recorded as a further check on the possibility that the pineal apparatus might influence thermoregulation. Temperatures were obtained with a rapid recording Schultheis thermometer, 0–50°C., inserted into the cloaca of the lizard immediately following capture. Care was taken to minimize contact between the hand of the investigator and the lizard in order not to alter the animal's temperature. If there was delay in obtaining the temperature, the record was discarded. All temperatures were taken with the same thermometer, the instrument used in the earlier study.

The study was carried out on the assumption that the parietal eye was a secretory organ. Efforts to discover a parietal eye nerve had failed. It was thought, therefore, that the pineal gland could be removed without damage to the "eye." Unfortunately, after the study was completed, a nerve was discovered (Eakin and Stebbins, 1959). Although



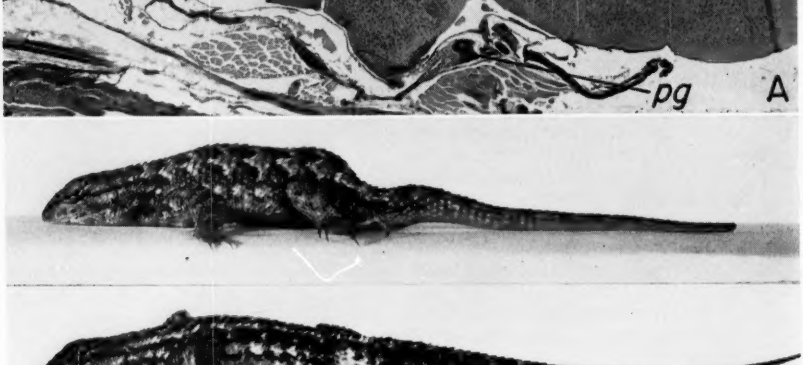


Fig. 1A. Median sagittal section through the brain of *Sceloporus occidentalis*, showing the relative positions of the parietal eye and epiphysis (pineal gland). Abbreviations: c, cerebrum; e, pineal gland; p, parietal eye; par, paraphysis; pc, posterior commissure; pcv, sinus of posterior cerebral vein; pg, pituitary gland. Horizontal line represents 1 mm. B. Kyphoscoliotic (above) and normal *Sceloporus occidentalis* from the field study area at Big Springs Canyon. The kyphoscoliotic, normal at the time of pinealectomy on July 3, 1957, was recaptured in the condition shown on September 12, 1957. Rate of growth during the interim had been normal.

tests have not been made, the structure of the nerve suggests that it is functional. Since the nerve is closely applied to the pineal gland, it is relatively certain that with pinealectomy, it was severed in most animals. Its capacity for regeneration and reestablishment of its connections are unknown. This discovery complicates interpretation of results. However, since in *Sceloporus* it does not appear that the gland can be removed without severing the nerve, the present technique is probably the best available in testing pineal function through pinealectomy in these lizards.

Surgery.—Before surgery each lizard was cooled to 5°C. in a refrigerator. It was then placed belly down in a tray of crushed ice, with only the head exposed. An ice cube wrapped in gauze provided a firm support for the head. After removal of the interparietal scale, the rear part of the skull was exposed by freeing a flap of skin from the skull and neck musculature. To free the skin a transverse cut was made a short distance behind the parietal eye and anterior to the posterior border of the interparietal scale. This cut formed the anterior part of the skin flap. The flap was rolled in on itself and was tucked down against the neck muscles near its point of attachment in order to prevent drying and interference with the operation.

With a dental drill (burr size No. 5) a hole was bored through the skull immediately in front of the insertion of the neck muscles. Care was taken not to perforate the dura with the drill. Gentle scraping of the dura with a scalpel exposed the posterior cerebral vein which is associated with the tip of the pineal. The pineal was removed with fine forceps. There was usually bleeding at this time owing to perforation of the vein, but the low temperature helped to minimize hemorrhage. In about one out of six animals, it was possible to remove the pineal without any indication of intracranial bleeding. Probably bleeding occurred which was not seen through the cranial opening.

The edges of the dura were drawn together and the flap of skin was placed into position. The interparietal stratum corneum, which had been removed as the first step in surgery, was now used to hold in place the anterior free edge of the skin flap which extended forward beyond its posterior border. All incisions were sealed with collodion and the lizard was kept overnight at 12°C. The surgery required between 5 and 10 minutes. The following day the animal was warmed to room temperature (23–25°C.). It was important to anchor the edge of the skin flap beneath the stratum corneum of the interparietal scale in order to prevent the skin from tearing loose when the lizard buried itself.

The sham-operation included perforation of the dura and rupture of the blood sinus, but the pineal was not removed. The tip of the gland was seized with forceps and tugged slightly.

Healing of incisions was complete in some animals within a month and in all within two months. No sign of infection was seen in any operated animal. No deaths among animals kept in captivity could be attributed to surgery.

The heads of all laboratory and some field lizards sacrificed for histological study were sectioned at the end of the experiments to determine the effects of surgery. The paraphysis was often removed along with the pineal. The roof of the diencephalon was frequently ruptured and the posterior cerebral vein was often modified. The habenular nuclei, posterior commissure, cerebral hemispheres (with rare exceptions), and optic lobes appeared normal.

Results

Exposure on the surface of the ground.—At the end of the study, in contrast with the parietalectomy experiment, the sham-operated animals had been recorded much more frequently on the surface of the ground than the pinealectomized ones (Fig. 2, tables 1 and 2). Although the overall effect of pinealectomy was to decrease the frequency of detection, from March 10 to May 23, when about half the animals (77) were marked, there were no significant differences. Indeed at the beginning 10 pinealectomized animals were recaptured 25 times (2.5 times per lizard), whereas 16 sham-operated animals were recaptured 21 times (1.3 times per lizard). In the next 18 days, however, 15 pinealectomized animals were captured 24 times (1.6 times per lizard), 19 sham-operated, 32 times (1.7 times per lizard).

Changes in exposure with time of day.—No differences were found between the two surgical types in exposure with time of day. Throughout the day the controls were about twice as likely to be encountered as were the experimentals (Table 3).

In the study of the effects of parietalectomy, it was found that observation of experimental and control animals differed with the time of day. The greatest differences (in favor of the experimentals) occurred in the morning and afternoon, whereas during midday the scores were nearly the same.

Changes in the location of field animals.—Pinealectomy resulted in what appeared to be an increase in locomotor movements in the study area. The lizards chosen for analysis were surgically treated animals that had been observed in the area two months or longer prior to October 26, 1957. This length of time was required for adequate healing and to permit possible disturbances of pineal function in the sham-operated animals to

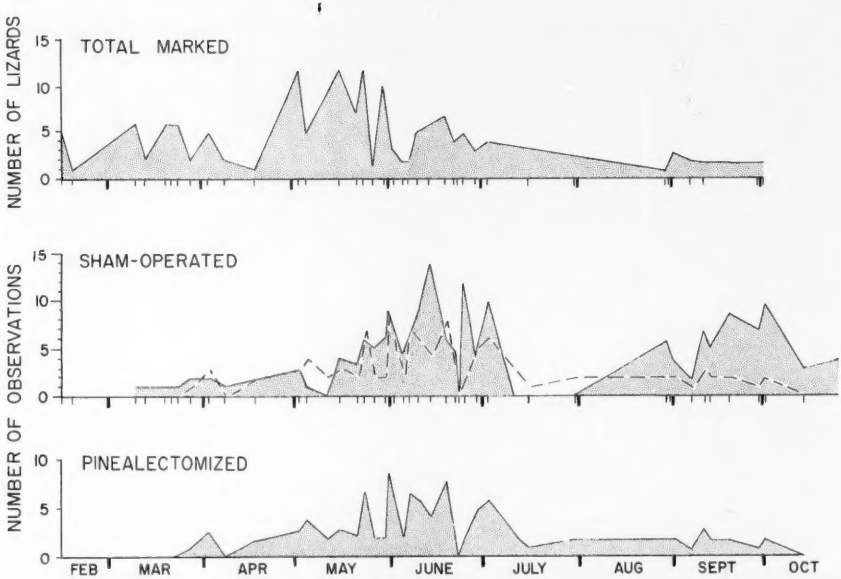


FIG. 2. Frequency of observation of sham-operated and pinealectomized *Sceloporus occidentalis* in the study area at Big Springs Canyon in 1957. The dashed line in the middle diagram represents the performance of the pinealectomized animals, superimposed on that of the sham-operated ones to facilitate comparison. Small vertical lines between the heavy lines separating the months indicated days on which observations were made.

TABLE 1. VISITS TO STUDY AREA IN WHICH FREQUENCY OF DETECTION FAVORED PINEALECTOMIZED, PARIETALECTOMIZED, OR SHAM-OPERATED FENCE LIZARDS (*Sceloporus occidentalis*)

	Score in favor of experimentals	Percentage total no. visits	Score equal	Score in favor of controls	Percentage total no. visits	Total no. visits
Pinealectomy experiment (Mar. 10, 1957–Oct. 26, 1957)	9	22.2	4	27	67.5	40
Parietalectomy experiment* (Oct. 23, 1955–Nov. 4, 1956)	40	63.5	8	15	23.8	63

* See Stebbins and Eakin (1958).

disappear. The average distance between observation points was calculated. Since it was found that the intervals in days between observations of pinealectomized lizards was approximately the same as in sham-operated ones, intervals between observations were not used in the calculation. The pinealectomized lizards averaged about ⅓ greater distance between points of observation ($P = 0.03$).[1] than did the controls (Table 4).

Although recaptures have been few, shifts in position of surgically treated lizards that reappeared the following spring are in accord with these results (Table 5). After overwintering the sham-operated animals were found within their home areas or near the original point of capture but the pinealectomized animals had become greatly displaced. The shift of 142 yards made by an adult male was equaled by a parietalectomized adult female but was over 5 times farther than any shift made by an adult sham-operated animal in either field study.

These results are in accord with those obtained in the parietalectomy experiment. Parietalectomized lizards after overwintering in 1956 averaged a 3 times greater shift from their home areas, as determined in 1955–1956, than did the controls.

Fright reaction and other behavior.—Pinealectomized lizards generally showed a

[1] Except where otherwise noted a two-tailed t test has been used.

TABLE 2. NUMBER OF POST-SURGICAL OBSERVATIONS OF MARKED FENCE LIZARDS (*Sceloporus occidentalis*)

	Parietalectomy Experiment (Sept. 3, 1955–June 19, 1957)					Pinealectomy Experiment (Mar. 10–Oct. 26, 1957)				
	Total no. of observations	Percentage of total	No. of lizards	Frequency per lizard		Total no. of observations	Percentage of total	No. of lizards	Frequency per lizard	
				Aver.	Range				Aver.	Range
Experimentals	551	55.0*	133	4.14	1–26	78	35.9	34	2.29	1–10
Controls	451	45.0	117	3.85	1–23	139	64.1	48	2.90	1–18

* On November 4, 1956, 12 months after the initial period of intensive marking and surgery in the course of the parietalectomy study, the percentages were: experimentals 58.2 and controls 41.8 (Stebbins and Eakin, 1958). This smaller difference shown here, some 8 months later, may be caused by adaptation to loss of the parietal eye or a higher mortality in the experimental animals than in the controls.

TABLE 3. FREQUENCY OF OBSERVATION OF PARIETALECTOMIZED, PINEALECTOMIZED, AND SHAM-OPERATED FENCE LIZARDS (*Sceloporus occidentalis*) IN RELATION TO TIME OF DAY[1]

Time of Day	I. Parietalectomy study			II. Pinealectomy study		
	Experimentals	Controls	P values	Experimentals	Controls	P values
Before 10 a.m.	84 (63.2)	49 (36.8)	<.01	18 (32.1)	38 (67.9)	<.01
Before 11 a.m.	162 (56.6)	124 (43.4)	.05	34 (32.1)	72 (67.9)	<.001
11 a.m. to 1 p.m.	114 (53.3)	100 (46.7)	.39	27 (36.0)	48 (64.0)	.01
1 p.m. to 7 p.m.	201 (58.3)	144 (41.7)	<.01	21 (36.8)	36 (63.2)	<.05

[1] Percentages of total observations in parentheses.

TABLE 4. MOVEMENTS IN THE FIELD OF PINEALECTOMIZED AND SHAM-OPERATED FENCE LIZARDS (*Sceloporus occidentalis*)[1]

	No. of lizards	No.* of shifts	Number yards between observation points		No. days between moves	
			Average	Range	Average	Range
Pinealectomized	13	54	10.6	4.2–18.3	26.8	64–184
Sham-operated	22	93	7.1	1.0–17.0	25.9	64–201

* Frequency of observation of individual lizards ranged from 1 to 10 (Average, 4.1).

[1] Lizards seen over a period of less than two months not included.

TABLE 5. DISTANCE BETWEEN FIRST AND LAST CAPTURE OF PINEALECTOMIZED AND SHAM-OPERATED FENCE LIZARDS (*Sceloporus occidentalis*) AFTER OVERWINTERING

	Growth (snout-vent in mm.)		Distance (yards)	Interval between first and last capture (days)
	1957	1958		
Pinealectomized				
♂ 419	5/18–68	3/16–68	74	308
♂ 518	6/25–46	4/25–63	142	330
♂ 535	9/29–64	3/4 –64	44	141
Sham-operated				
♀ 411	3/28–40	4/15–69	8	383
♂ 420	5/3 –43	5/9 –70	8	362
♂ 450	5/21–43	4/8 –60	5	320
♀ 458	5/23–46	4/8 –65	7	343
♀ 526	7/3 –50	4/25–65	6	292
♂ 536	9/23–66	4/25–66	27	193

marked fright reaction. In both field and laboratory, especially toward the end of the study, the tendency to take cover was pronounced, and in the field, the pinealectomized lizards became difficult to find. In view of the results on movement, this may have been caused in part by dispersal out of the area. The effect of mortality on the field results is unknown. In contrast, parietalectomized lizards were less inclined to retreat than were the controls.

The struggles of pinealectomized lizards taken in hand were subjectively recorded as more violent, erratic, and frequent than those of the controls. In an effort to provide some degree of objectivity, each attempt to bite made by lizards caught in the field was recorded. In the period from February 14 to

TABLE 6. COMPARISON OF BODY TEMPERATURE IN FENCE LIZARDS (*Sceloporus occidentalis*) WITH AND WITHOUT PINEAL DAMAGE

	Period of recording	No. of animals	Total no. of records	Temperature, °C.	
				Aver.*	Range
Pinealectomized	Feb. 14–Oct. 26, 1957	32	47	34.4	26.8–38.6
Sham-operated		47	87	35.5	33.0–38.2
Unoperated		50	51	35.1	28.3–39.4
Parietalectomized	Sept. 9, 1955–May 30, 1957	37	42	33.4	21.0–37.5
Sham-operated	Sept. 10, 1955–May 23, 1957	28	30	34.5	32.0–39.5
Unoperated	Sept. 2, 1955–Oct. 16, 1956	57	57	34.8	29.3–38.5

* In calculating group averages, a single temperature record was used for each lizard. For those individuals in which there was more than one record, an average was obtained.

October 26, 1957, 7 pinealectomized lizards made 21 attempts, 10 controls 11. But these observations are too few to make possible a sound conclusion.

A posture frequently assumed by some of the pinealectomized laboratory animals when on the surface of the sand suggested that often seen in normal lizards when they are stalked. The head is placed against the ground, eyes widely open and limbs flexed. Further approach may cause rapid retreat. This position was so frequently seen in captives as to suggest an accentuation of the state of alarm or readiness.

Body temperature.—Cloacal temperatures were recorded in field animals exposed on the surface of the ground from February 14 to October 26, 1957 (Table 6). The mean temperature of pinealectomized animals was 1.1°C. below that of the sham-operated controls ($P = 0.02$). This has led to reexamination of the effects of parietalectomy. Temperature records for parietalectomized and sham-operated lizards in our earlier study have been reevaluated and a few additional records, not reported earlier, have been included. In the instances where two or more records were available for a single individual, an average temperature has been determined; thus each record used in obtaining the group average represents a single lizard. Previously, all temperatures had been lumped (Stebbins and Eakin, 1958), statistically a less desirable procedure. On this basis the parietalectomized lizards average 1.1°C. lower than the sham-operated ones (Table 6). This difference, though in the same direction as in the pinealectomy study, is not at the level usually regarded as statistically significant but the value of t is close to the critical value.

It would appear that in fence lizards with pineal damage there is a lowering of the mean temperature of lizards exposed on the surface of the ground. That this may be caused in part at least by emergence and retreat at a lower temperature than the controls is suggested by the fact that of 32 pinealectomized lizards, 7 (21.9 per cent) were recorded below 33°C. whereas of 47 sham-operated lizards only 2 (4.3 per cent) were below 33°C. ($P = 0.04$).[2]

Kyphoscoliosis following pinealectomy.—Among sixteen young pinealectomized fence lizards that were recaptured in the field after the elapse of two months, two showed marked and one mild kyphoscoliosis (Fig. 1, B). Two of 6 pinealectomized lizards in the laboratory developed scoliosis. Examination of the skeletons of the field animals by X-ray and direct study, revealed no osteological deformation. The small number of animals developing curvature may mean that collateral brain damage, rather than removal of the pineal, was responsible for the deformity. In the two field animals with marked kyphoscoliosis the paraphysis had been dislodged in the course of surgery and had grown to the posterior part of the cerebrum. The third ventricle appeared to be enlarged. Thus the spinal deformity cannot be attributed to removal of the pineal alone. Previous investigations of the relationship of spinal curvature to pinealectomy in other vertebrates (Pflugfelder, 1953, 1954, 1957, Kelley, 1958) have not yielded consistent results.

Negative results.—No difference between pinealectomized and sham-operated lizards were noted in coloration, either in the field or laboratory. Field animals showed similar growth rates during the period from March to October, 1957, as based on 12 pinealectomized and 21 control lizards. By October most animals had reached adult size. Pinealectomized lizards in the laboratory, however,

[2] Chi-square test.

gained weight and grew in length slightly less rapidly than the sham-operated controls and the latter, in turn, slightly less so than unoperated animals.

Summary

The possibility that the parietal eye may be a sense organ important in modulating the activity of the pineal gland in the western fence lizard has been explored by means of separate experiments involving extirpation of the "eye" (parietalectomy) (Stebbins and Eakin, 1958) and removal of the pineal gland. Results of pinealectomy are reported here.

The expectation that removal of the pineal might be followed by changes similar to those resulting from parietalectomy was realized in part, but parietal eye impairment may have occurred also. Both surgical types made greater changes in position within the study area than the controls. This may reflect increased locomotor activity in lizards with pineal damage.

Results of study of body temperature were less convincing. Pinealectomized animals exposed on the ground had lower mean body temperatures than did the controls. Although differences between experimentals and controls in the parietalectomy experiment were in the same direction and of the same magnitude (1.1°C.), they were doubtfully significant. Lowering of the mean may be caused by a lowering of the thermal threshold for emergence and retreat.

Dulling of the fright reaction, accentuation of exposure to full sunlight, and differences in activity with time of day seen in parietalectomized lizards were not noted in pinealectomized ones. As pointed out in our earlier report (Stebbins and Eakin, 1958), the first two phenomena are probably related. Indeed, the pinealectomized lizards were more excitable and prone to retreat in the presence of the observer than the controls. Spinal curvature, noted in a small percentage of the pinealectomized lizards, was not observed in parietalectomized animals.

Removal of the pineal resulted in injury to the parietal eye nerve, frequent removal of the paraphysis, and occasionally other collateral damage. This must be taken into account in evaluating results. Survival following surgery was good. Pinealectomized lizards were as viable as the sham-operated controls over the period of experiments in the laboratory. Two field animals were caught a year after pinealectomy and appeared to be in good condition. Recapture of marked normal animals over this length of time in the field is not frequent.

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The Status of a Mexican Lizard, *Eumeces lynxe belli*

Richard B. Parker

IN this paper I intend to show that *belli* is not applicable to a form of *Eumeces* inhabiting the eastern coastal plain of Mexico; to show that *E. l. belli* is a valid form inhabiting the Sierra Madre Occidental; to give additional information on *E. l. belli*; and to give characters by which it can be readily separated from other members of the *lynxe* group. This group as defined here includes those forms of five-lined *Eumeces* that have the median light line extending down to the frontal instead of bifurcating on the nuchal; it includes *E. lynxe*, *E. sumichrasti*, and the *E. belli* of Smith and Etheridge.

Taylor (1935) synonymized *Plestiodon bellii* Gray with *Eumeces lynxe*. Smith and Etheridge (1953) resurrected the specific name, *bellii*, and applied it to a form of *Eumeces* inhabiting the eastern coastal plain of Mexico. The recently described *E. lynxe durangoensis* (Tanner, 1958) is not distinguishable from *E. l. belli* and the specimens reported on by Smith and Etheridge (op. cit.) are not referable to *E. l. belli*. Legler and Webb (1960) have already synonymized *E. l. durangoensis* with *E. l. belli* but they do not discuss reasons for their action.

The specimens that Smith and Etheridge called *E. belli* do not agree with the type in two important characters: the number of dorsal scale rows and the number of lamellae on the fourth toe (see Table 2). The median light line on the head of the type is anomalous and Smith and Etheridge assumed that the normal condition was bifurcate. Additional material and further study is needed before the status of these specimens can be determined; therefore, they shall be referred to as *E.* sp A in this paper. However, the Sierra Madre Occidental material agrees with the type of *bellii* in all observed characters as does the description of *E. lynxe durangoensis* (Tanner, 1958).

I have examined 11 specimens of *E. l. belli* from Durango and four from Zacatecas and have obtained additional information on the type. The condition of some individuals makes it impossible to obtain complete data from all. Reference should be made to Tanner's account (op. cit.) of *E. l. durangoensis* for a general description of *E. l. belli*. To supplement his account I have discussed additional characters and have given the variation of others.

Variation

The median light line ends on the anterior part of the frontal or the posterior part of the frontonasal. The average number of dorsal scale rows from the occiput to above the anus is 64.8 (63 in three specimens, 63 or 64 in the type, 64 in one, 65 in six, 66 in two, 67 and 68 in one each). The frequency of occurrence of the number of lamellae is given in Table 1. The low values for lamellae and the high values for dorsal scale rows are indicative of relatively short limbs, which do not overlap when adpressed in either adults or young. The limbs of the females are relatively shorter than those of males. A female of 59.0 mm. snout-vent length has hind limbs 14.5 mm. long, whereas two males of 50.7 mm. have hind limbs 18 and 16 mm. long. The number of scale rows around the body is 24, except in one damaged specimen that apparently had 23. The primary temporal is usually in contact with the parietal.

Relationships and Recognition

In Table 2 some of the characteristics of *E. l. belli, l. lynxe, sumichrasti,* and *E.* sp A are compared. Specimens of *E. l. belli* of all sizes have an unforked median light line. It can be distinguished from all other species of the genus by this character. If, as is often true of larger individuals of the members of the *lynxe* group, the markings on the head are not clear, then *E. l. belli* can also be distinguished from *E.* sp A and *E. sumichrasti* by the smaller number of lamellae on the fourth toe (12 or less versus 14 or more) and by the greater number of dorsal scale rows (63 or more versus 59 or less). *E. l. belli* can be distinguished from *E. l. lynxe* as well as *E. sumachrasti* by the absence of a lateral light line. In this last character it resembles *E.* sp A. *E. l. belli* is most closely related to *E. l. lynxe*; both have the same number of postlabials, contact between the primary temporal and the parietal, the same number of scale rows around the body, the same type of development, and occur at similar altitudes (these last two may be related). *E. l. belli* is known to be ovoviviparous since one of the Zacatecas specimens, University of Michigan Museum of Zoology (UMMZ) 118534, was removed from the oviduct of another, UMMZ 118531. *E. l. belli* has the greatest number of dorsal scale rows and

TABLE 1. FREQUENCY OF NUMBER OF LAMELLAE ON DIGITS[1] IN *Eumeces lynxe belli*

	number of lamellae								
	3	4	5	6	7	8	9	10	11	12
First finger	1	23	2							
Second finger				1	19	5				
Third finger						6	12	7		
Fourth finger							11	14		
Fifth finger			12	14						
First toe		12	12							
Second toe				2	16	7				
Third toe						1	11	9	4	
Fourth toe								1	16	6
Fifth toe				1	14	10				

[1] Counts of left and right digits.

the smallest number of lamellae on the fourth toe but is most closely approached by *E. l. lynxe* in these two characters.

HABITAT

The specimens from Zacatecas were collected in an area of pine forest mixed with a few oaks. The lizards were taken about six inches below the surface of the ground. I found these specimens while digging out a small burrow. The specimens from El Salto, Durango, collected by Webb and Fugler, were found under rocks in an open area dominated by pinon pine. The specimens from Rancho Las Margaritas, Durango, were collected by Webb from under rocks and logs in a mountainous area dominated by pine, oak, madrono and manzanita. Photographs of this last locality are presented by Drake (1958); *E. l. belli* is referred to in his paper as *E. lynxe*.

REMARKS

Eumeces l. belli occurs on the western side of the Mexican plateau in the Sierra Madre Occidental whereas the rest of the *lynxe* group is confined to eastern Mexico (Fig. 1). Martin (1958) postulated that at some time during the Pleistocene pine-oak forest areas extended across the Mexican plateau well to the north of the transverse volcanic belt and served as dispersal routes. Such a route may have been used by *E. l. belli* or its ancestors since the relationships of this form are clearly with the *lynxe* group, all members of which are restricted to forested areas.

Eumeces l. belli may merit specific rank. The degree of difference between *E. l. belli* and *E. l. lynxe* is of the same order as the differences between many other currently recognized species in the genus. Since there is no definite proof that it is a species or a subspecies I have chosen the more conservative course and left the name as it has already been presented by others (Legler and Webb, op. cit.).

MATERIAL AND DISTRIBUTION

Zacatecas. 16 miles west of Milpillas (about 67 miles west of Fresnillo), 8200 ft., UMMZ 118531–4. *Durango.* 30 miles east of El Salto, 7500 ft., University of Kansas Natural History Museum (KU) 44734–5: 10 miles east of El Salto, 7500 ft., KU 44736; Rancho Las Margaritas, 28 miles south and 17 miles west of Vicente Guerrero, 8350 ft., Michigan State University 220–7. There are no locality data for the type specimen. As presently known *E. l. belli* occurs at elevations above 7000 ft. in southern Durango and west-central Zacatecas (Fig. 1).

Acknowledgments.—I am very grateful to Charles F. Walker and Norman E. Hartweg,

TABLE 2. COMPARISON OF SPECIES IN THE *Eumeces lynxe* GROUP

	belli	*lynxe*	sp A	*sumichrasti*
Number of specimens	16	41	2	5
Median light line	unforked	forked	forked	forked
Middorsal scale rows	63–68	59–63	55–59	48–57
Lamellae on 4th toe	10–12	11–15	14–16	15–21
Scale rows around body	24	22–26	24–26	26–30
Postlabials	1	1	1	2
Primary temporal and parietal	contact	contact	separate	separate
Lateral light line	absent	present	absent	present
Development	ovoviviparous	ovoviviparous	?	oviparous
Altitude	highland	highland	lowland	lowland

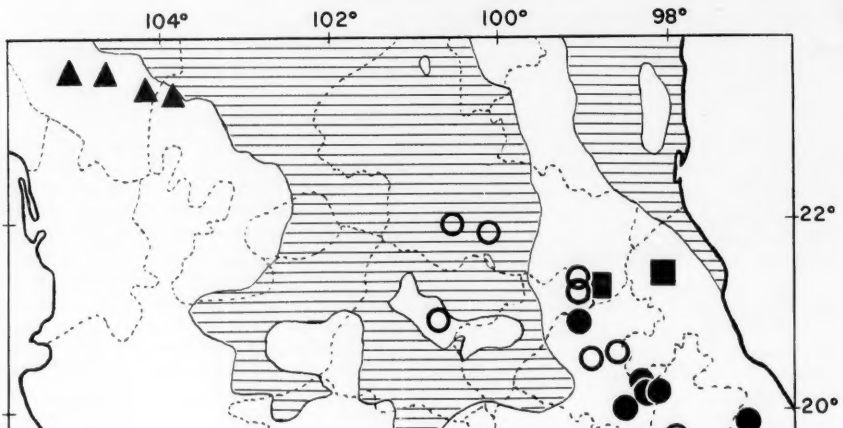

Fig. 1. Distribution of the *Eumeces lynxe* group in central Mexico. Shaded areas indicate grass lands, open areas indicate forests. Open symbols are literature records.

University of Michigan Museum of Zoology, for their assistance in many ways; to Robert G. Webb for the loan of specimens and information; to J. C. Battersby, British Museum of Natural History, for information on the type; and to Max Hensley and Rollin H. Baker, Museum, Michigan State University, for the loan of specimens.

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Studies on the Life History of the Salamander, *Plethodon welleri*

JAMES A. ORGAN

PLETHODON welleri Walker has been recognized as a distinct species since 1931 but nothing has been published on its life history.

Studies on the population dynamics of *Plethodon welleri,* begun in 1957 and still in progress, indicate summer brooding and fall courtship periods. In 1958, eggs were found in the field and courtship behavior by captive salamanders was witnessed in the Mount Rogers-Whitetop Mountain area of southwestern Virginia.

Acknowledgements.—I am indebted to Norman E. Hartweg and Charles F. Walker of the Museum of Zoology, University of Michigan and to Charles M. Bogert and Richard G. Zweifel of the American Museum of Natural History for permission to examine embryonic material of the genus *Plethodon*. My wife, Della S. Organ, has given unstinting assistance in field and laboratory.

Travel expenses during the summer of 1958 were defrayed, in part, by a grant from the Horace Rackham School of Graduate Studies of The University of Michigan and funds from an anonymous donor made possible the continuation of the field studies during the month of October, 1958. For this generous assistance, I am extremely grateful.

The specimens of *P. welleri* discussed in this paper are in the collection of the Museum of Zoology, The University of Michigan, numbers 119831-8.

Nest Site

The species is found in Virginia from an altitude of 4400 feet to the summits of Whitetop Mountain (5520 feet) and Mount Rogers (5715 feet). Greatest concentration occurs in spruce-fir forests there from 5000 feet upward.

Eight nests, discovered from mid-August to early September, 1958 (Table 1), were in well-rotted conifer logs of the forests between the rotting upper surface and a mat of moss from 2 to 4 inches thick. Six of the nests were near the ends of logs and two midway between ends. Nest 5 and 6 (Table 1) were within a foot of one another in one log; the others were in different logs.

Most of the egg masses were attached above a longitudinal fissure in a log. The material surrounding the egg mass was thoroughly saturated.

Egg Mass

Three clusters, discovered on August 16, had attending females and well-developed embryos. The remaining clusters, found at later dates, had attending females, recently hatched young, and empty egg capsules.

The egg mass of *P. welleri* is a tight grape-like cluster of from four to 11 eggs. It is usually suspended by a single, tough, whitish stalk (Figure 1, A). The innermost eggs are directly attached to the stalk, which flares over their outer capsules. The eggs at the periphery are attached to each other and to the inner ones by adhesion of the outer capsules (Figure 1, B).

The empty capsules of the smallest clutch (Table 1, Nest 5) lacked a stalk and adhered to one another at the bottom of a fissure.

Eggs and Egg Capsules

The eggs collected on August 16 were in later stages of development. The capsules were spherical and transparent. The diameter of the outer capsules, prior to preservation, varied from 5.5 to 6.5 mm. The diameters of the five eggs from Nest 1 (Table 1) were 6.0, 5.5, 5.5, 6.0, and 5.5 mm., with a mean of 5.7. The measurements of six of the ten eggs from Nest 2 (Table 1) were 5.5, 6.0, 5.5, 6.5, 6.0, and 6.0 mm. (mean 5.9). The clutches from Nests 2 and 3 were incubated and hatched in the laboratory and further measurements of egg diameters were impossible.

The egg has three distinct capsules. The inner or vitelline membrane is thin and encloses the embryo in a watery sphere. The second capsule, also thin, is separated from the inner one by a thin layer of fluid. The outer capsule is thicker than the others and encloses a thicker layer of fluid. This outer capsule is very adhesive, clinging not only to other eggs but to debris as well (Figure 1, B).

Embryos

The position of the embryos within the egg capsules is shown in Figures 2 A and B. Embryos within the eggs react negatively

TABLE 1. NESTS AND THEIR CONTENTS

Nest Number	Date of Collection	UMMZ Catalog Number	Altitude in Feet	Number of Eggs	Number of Hatchlings	Females	
						Snout-Vent Length (mm.)	Total Length
1	16 Aug.	119833	5650	5		45.5	81.5
2	16 Aug.	119832	5600	10		43.5	74.0
3	16 Aug.	119834	5475	6		46.0	81.0
4	18 Aug.	119831	5450		7	48.0	90.0
5	30 Aug.	119835	5200		4	46.0	83.0
6	30 Aug.	119836	5200		6	42.5	74.5
7	30 Aug.	119837	5300		11	45.5	83.0
8	5 Sept.	119838	5700		6	—	—

Nest 4 from north side of Whitetop Mountain, all others from the south side of Mount Rogers. "Snout-Vent" is the measurement from the tip of the snout to the posterior angle of the vent.

to light and quickly rotate until the head is directed away from the light source. The rotation is accomplished by rapid flexing of the body while the limbs, tail or both are thrust against the inner capsule.

Two embryonic larvae from Nest 1 (Table 1) were dissected from their egg capsules prior to preservation on the day they were collected. The limbs and digits were well formed but digital joints were not apparent. The hind limbs were slightly longer than the forelimbs (Figure 2, C and D). The yolk was prominent and protruded from the belly region as a large yellow hemisphere. The head was large and the eyes and external nares prominent. The eyelids were poorly developed and the tail was relatively short and circular in cross-section.

Pigmentation was lacking in the region of the nares, on the chin, throat, belly, and mid-ventral line of the tail. There was a wide lightly pigmented stripe on each side of the head extending from the posterior border of the eye through the gill base to the gular fold. The dorsal pigmentation extended down the sides of the body and gradually faded over the region of the yolk. There was a thin groove along the mid-dorsal line which, like the costal grooves, was unpigmented (Figure 2, C). There was no dorsal brassy pattern but a few iridophores were scattered over the dorsum of the head, body, and tail.

After five months of preservation, the iridophores were no longer evident. A dorsal stripe, obscured in life by the iridophores, is clearly revealed. This stripe appears to be brownish but is merely an area less densely pigmented than the sides. The borders of the stripe are straight but are not heavily outlined by dense pigmentation as in the red-back phase of *Plethodon cinereus*. The stripe extends from the back of the head along the mid-dorsal line to the base of the tail.

Three gills of different lengths arise from a common base. They are long, slender, antler-like, and without pigment (Figure 2, C). The anterior and shortest gill almost reaches the tip of the snout. The first gill has five prongs, the second and third have seven each.

The main stem of each gill contains an arterial loop which gives rise to and receives a small capillary loop in the region of each prong. Although the gills are joined in a common base, the arterial loop of each passes through the base independently.

When the embryos were dissected free from their egg capsules into a small container, they immediately began to walk well and would right themselves normally when turned on their backs. They moved through the shallow water freely in spite of the gills and the large yolk. The embryos showed strong negative responses to light. When examined, these embryonic larvae were estimated to be less than a week from hatching.

HATCHING PROCESS

The egg masses from Nests 2 and 3 (Table 1) hatched in the laboratory. The ten eggs from Nest 2 began at 7:15 A.M., August 19. At 12:45 P.M. on the same day, three of the eggs from the periphery of the mass were removed and preserved. The remaining seven hatched by 8:00 P.M., August 21. The six eggs from Nest 3 were left intact throughout the hatching process, which began at 11:00 A.M. on August 23 and was completed at 4:43 P.M. on August 24.

As the eggs approach hatching, they enlarge slightly and become slightly ovoid. The eggs at the periphery of the mass are the first to hatch and produce well-developed young with small gill remnants and relatively little yolk (Figure 1, B and C; Figure 2, E). The more centrally located eggs produce smaller, less well-developed young with large yolk supplies and with gills only slightly reduced from the embryonic condition.

Immediately prior to hatching, the em-

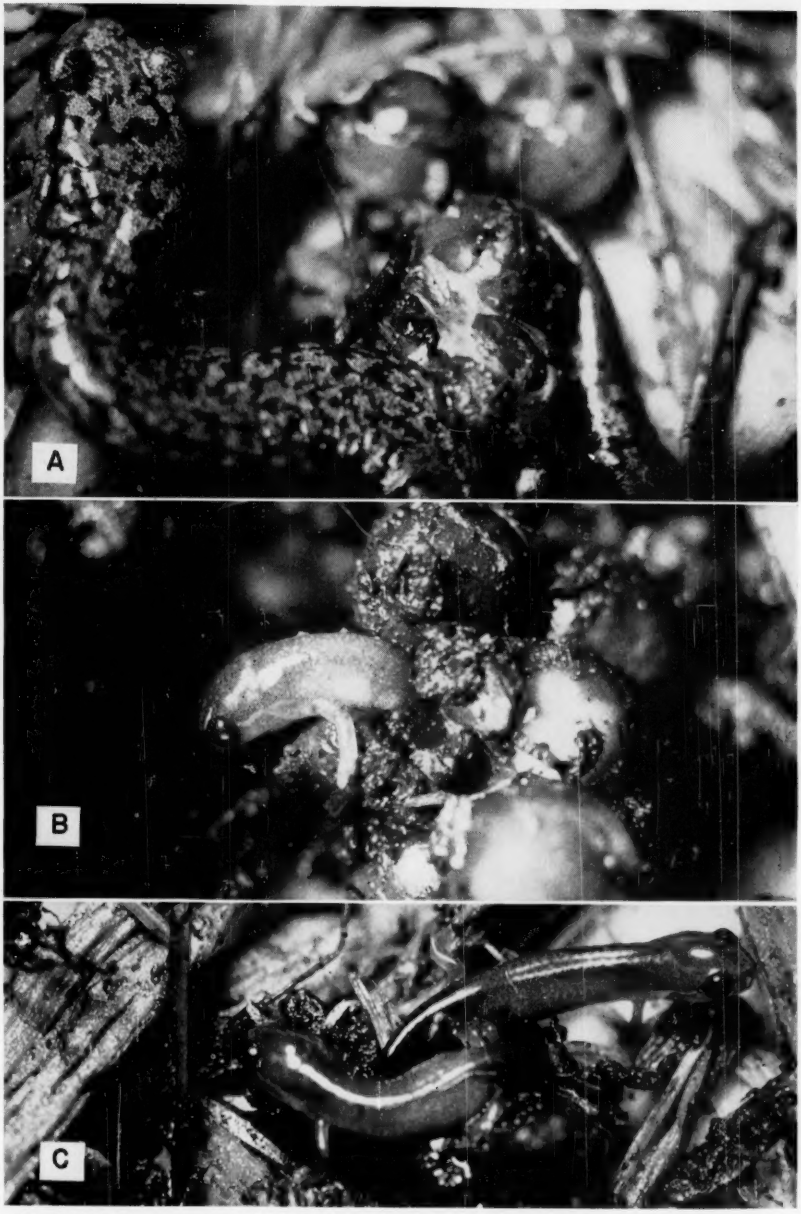

Fig. 1. Hatching sequence of *Plethodon welleri*. A. Attending female with eggs from Nest 1. Note white attachment stalk on eggs in foreground and tail of female to the right of the eggs. B. Hatchling partially expelled through ruptured egg capsules. C. Recently hatched young from Nest 2 photographed one hour after hatching.

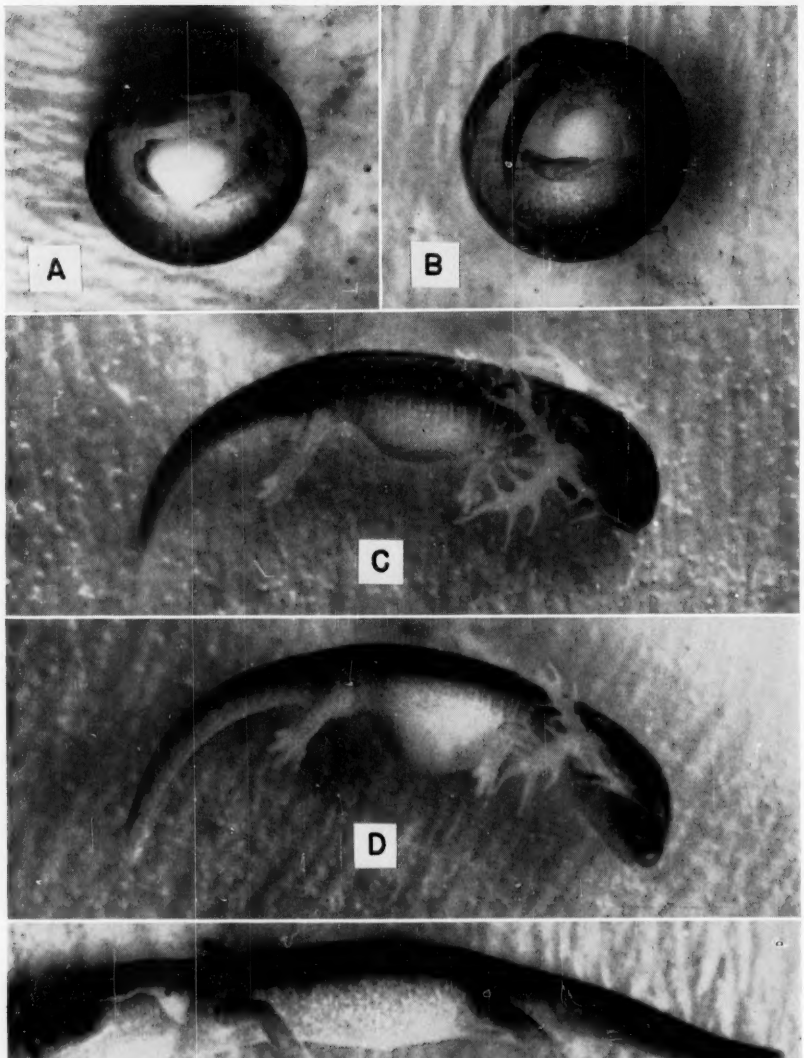

Fig. 2. Embryos and hatchlings of *Plethodon welleri*. A. Normal position within egg capsules. Left view with capsules removed after preservation. B. Same as "A". Right view. C. Right dorsolateral view of embryo showing gill structure and lack of pigmentation in mid-dorsal line. D. Right lateral view of embryo. E. Left lateral view of hatchling approximately three hours old.

bryos engage in vigorous turning movements with short rest periods. During these prehatching movements, the limbs and tail are often thrust outward from the body and the elastic egg capsules are stretched considerably in the region of these extremities.

The capsules appear to weaken first and then rupture in the region of the snout of

the embryo and the head and forelimbs are forcibly expelled through the ruptures with the escaping egg fluid (Figure 1, B). The ruptured capsules then close tightly around the middle of the body of the hatchling like a purse string and the young salamanders may remain in this semihatched position from a few minutes to two hours before they struggle to free the hind limbs and tail. After the hatchling frees itself, it remains close to the egg mass and the attending female (Figure 1, C).

Hatchlings reared in captivity were preserved within 24 hours after hatching and, during that period, the young did not leave the vicinity of the egg mass and the attending female. Recently hatched young found in the field with attending females varied in the quantity of yolk present but all had lost their gill remnants.

Recently Hatched Young

At hatching, the young vary considerably in length and development. The following description is based largely on young from the periphery of the egg mass; those from the more central eggs are intermediate in development.

The head is large and the eyes prominent with well-developed eyelids (Figures 1, C and 2, E). The nares are considerably reduced from the embryonic condition but still proportionally larger than in the adult. The limbs are well developed and functional but distinct joints are still not evident in the digits. The hind limbs are slightly longer than the forelimbs. The tail is circular in cross-section and proportionally longer than in the embryo. The general pigmentation is much darker than in the embryo but the under surfaces of the limbs and the mid-ventral line still lack pigment. The chin is unpigmented except for a few scattered melanophores in the mid-ventral line. The undersurface of the tail is well pigmented but lighter than the rest of that structure.

The hatchling has more iridophores scattered over the dorsum than does the embryo, but has no distinct brassy pattern. The yolk is considerably reduced but still forms a slight bulge in the belly region.

The gills are reduced to finger-like projections, each of which is supplied with a single unbranched arterial loop. These finger-like remnants are usually lost within 24 hours after hatching.

Hatchlings from the more central eggs of a clutch have gills only slightly reduced from the embryonic condition. During the first 24 hours after hatching, however, the gills are rapidly reduced in size and complexity until they resemble the remnants present in the earlier and more well developed hatchlings.

The gills are reduced simultaneously but the circulation within the gills is lost in a definite anterior to posterior sequence. First the more proximal capillary loops are lost and then the more distal ones, as the main arterial loop is resorbed with the gill. This reduction takes place in the anterior gill first, then in the second, and finally in the posterior one. The circulation in each member of a pair of gills is not always lost concurrently; a gill on one side of the head may remain functional for an hour or two after the circulation has been lost in the corresponding one on the other side. The anterior to posterior sequence of resorption, however, remains evident.

Tables 2 and 3 list the measurements for the recently hatched young from each nest prior to preservation. The young from Nests 2 and 3, reared in captivity (Table 2), were known to be less than 24 hours old when measured and either still retained their gill remnants or had recently lost them. These compare favorably in size with the young from Nest 4 (Table 3), collected on August 18, one day prior to the beginning of hatching in captive eggs masses. The young from Nests 5 through 8 were taken in the field at later dates (Table 1) and are presumably slightly older than the young from Nests 2, 3, and 4.

Transformation

Transformation in *P. welleri* is restricted to the loss of the gills. No striking change in color pattern occurs until a day or two following the resorption of the gills. At that time the iridophores on the dorsum of the body coalesce to form a pattern. The pattern varies from hatchling to hatchling but in two of the young it consisted of six pairs of distinct brassy, paravertebral spots from above the axilla to above the groin. The majority of the transformed young had from one to five distinct pairs of spots on the anterior part of the dorsum, with the more posterior spots fused along the mid-dorsal line to form a ragged edged brassy stripe. The adult brassy pattern presumably results from a further fusion of the spots and an extension of the dorsal pattern on to the head, tail, sides, and limbs.

TABLE 2. SNOUT-VENT AND TOTAL LENGTHS (mm.) OF YOUNG HATCHED IN CAPTIVITY

Nest 2		Nest 3	
Snout-Vent	Total	Snout-Vent	Total
13.0	19.5	13.5	20.5
12.5	19.0	13.5	20.0
12.5	19.5	13.5	21.0
13.0	19.5	13.5	20.0
12.5	19.5	12.5	17.5
12.5	20.5	11.7	17.0
12.0	20.5		

TABLE 3. SNOUT-VENT AND TOTAL LENGTHS (mm.) OF YOUNG HATCHED IN THE FIELD

Nest 4		Nest 5		Nest 6		Nest 7		Nest 8	
Snout-Vent	Total	Snout-Vent	Total	Snout-Vent	Total	Snout-Vent	Total	Snout-Vent	Total
13.5	21.0	14.5	22.0	14.2	22.0	14.2	21.5	14.5	—
12.7	20.0	14.5	21.5	15.0	22.5	14.5	22.0	14.5	23.5
13.0	20.5	14.5	21.5	14.0	22.5	15.0	22.0	14.5	23.0
12.5	—	14.0	21.0	14.2	22.0	14.0	20.7	14.5	22.0
13.2	20.5			14.5	22.5	14.5	21.5	14.5	23.0
12.7	20.7			14.0	21.0	14.5	21.5	13.5	19.0
13.0	20.5					14.5	22.0		
						14.0	20.5		
						14.0	21.0		
						13.0	18.5		
						14.5	—		

Examination of recently hatched young preserved five months revealed no iridophores. The areas that had possessed distinct brassy spots, however, were either unpigmented or more lightly pigmented than the surrounding areas. All of the recently hatched young had the same kind of straight-edged lightly pigmented stripe seen in the preserved embryos. As in the embryos, the stripe had been obscured in life by the scattered iridophores and the brassy spots. The preserved specimens revealed the relationship of the brassy spots to the underlying lightly pigmented stripe; all of the spots had formed along its lateral borders. The dorsal pattern of the preserved hatchlings of *P. welleri* was strikingly similar to that of the young in *Plethodon yonahlossee*.

The ventral spotting, so characteristic of the subspecies *Plethodon welleri ventromaculatus* (Thurow, 1956), was not evident in most of the less well-developed young because the black pigmentation was not dense enough to reveal the white spots. All of the young from Nest 8 and many from Nests 5, 6, and 7, however, had some indication of ventral spotting (Table 1).

ATTENDING FEMALES

The attending females from Nests 1 through 7 were collected with their eggs and young (Table 1); none of the females attempted to escape, even when the nests were completely exposed. The females were invariably coiled around the egg mass or hatchlings and were docile; none attempted to bite.

The females from Nests 2 and 3, kept with their eggs until the young emerged (Figure 1, A), displayed typical plethodontid brooding behavior. They remained coiled loosely around the eggs and were most often observed with the head thrust into the center of the egg mass or with the chin resting upon it. The respiratory movements of the throat of the females kept the eggs in gentle but constant motion. The females abandoned the eggs when they were examined and photographed but soon returned to them after the disturbance ended.

When the young hatched, the female apparently remained oblivious to them and continued to stay with the empty egg capsules. The hatchlings remained close to these capsules and the female, presumably obtaining some moisture from both sources.

All seven of the attending females were very much emaciated when they were collected and, with the exception of those from Nests 2 and 3, were preserved on the day they were collected. Their digestive tracts contained no trace of food.

The attending female from Nest 8, unlike the seven females found at earlier dates with eggs or hatchlings, immediately attempted to escape when disclosed. The hatchlings also tried to escape so the retreating female was ignored in favor of gathering up the rapidly scattering brood. The young of this brood were the most well developed of those encountered. They had lost much of their yolk, had distinct dorsal and ventral patterns, and were larger than the young found previously in the field. When the nest was uncovered, the hatchlings were scattered over an area approximately 6 inches in diameter and the female was coiled around only three hatchlings in a fissure in the log. The young salamanders were obviously in the process

of dispersing from the nest and the strong behavioral pattern that keeps the attending female close to her eggs and young was weakening.

Courtship

In contrast to specimens collected during the spring and summer months, males of *P. welleri* taken in the fall have well-developed circular mental glands.

Recently captured specimens of *P. welleri* were kept under observation during the months of August, September, October, April, May, and June, 1958–59. The captives were maintained in small groups of four to eight in large glass finger bowls. The substrate was moist paper toweling and the water vapor content of the atmosphere within the containers was close to, if not at, the saturation point. None of the salamanders was maintained for more than two weeks.

Incomplete courtships were observed on October 4, 5, 7, and 11. Complete courtship through spermatophore deposition was observed on five occasions; once on October 9–10, twice on October 19–20, and twice on October 20–21. Courtship in captive *P. welleri* was nocturnal; no courtship activity was observed prior to 9:00 P.M.

Prior to courtship, the male becomes restless and moves around the container occasionally touching his nasolabial projections to the substrate. When he comes close to another salamander, his bucco-pharyngeal movements quicken and his tail immediately begins to undulate laterally.

The undulations begin at the base of the tail and pass posteriorly to a point approximately two-thirds from the base. The posterior third of the tail remains straight and is whipped back and forth as the serpentine wave reaches it. The tail undulations were timed on several occasions with a stop watch and found to be constant in frequency. The mean frequency of waves at 22°C was 1.5 per second.

Following this "tail-wagging" approach, the male brings his nasolabial projections and mental gland in contact with the body or tail of the female and slowly advances towards her head, holding his chin against her skin.

These preliminary phases are variable in duration but the male ultimately reaches her head, breaks contact between his chin and her head, and circles under her chin. As he passes beneath her, he holds first his back and later his undulating tail in contact with her chin. As his tail passes under her chin, he arches the base of his tail upward and begins a series of vertical undulations that alternate with the horizontal undulations that have been in evidence since the early phases of courtship. The female then raises one of her forelimbs over the tail of the male and maintains a straddled position with her chin pressed against the base of his undulating tail. The courting pair then move forward slowly in a tail-straddling walk.

The tail-straddling phase of courtship in this species is short and the courting pair rarely move more than 3 inches from the point at which the female places her forelimbs astride the tail of the male to the point at which the male deposits a spermatophore.

Just prior to spermatophore deposition, the male begins a series of lateral sacral rocking movements and the female moves her head laterally in synchronization with, but counter to, his sacral movements. The male lowers his swollen vent to the substrate and rhythmic muscular contractions occur in the region of the cloaca. He then quickly raises his vent, leaving a spermatophore adhering to the substrate, and arches the base of his tail upward. At the same time, he withdraws his tail from beneath the female and bends it sharply to one side. The female keeps her chin pressed against the sharply bent tail of the male and the courting pair move forward rapidly until the vent of the female comes in contact with the spermatophore. The female picks up the cap from the spermatophore with her cloacal lips, leaving the stalk of the spermatophore adhering to the substrate.

A female that is reluctant to court either flees from the male or raises her head until contact between her chin and the body of the male is broken. When the latter occurs, the male usually reapproaches the female and again tries to establish contact with her chin.

Courting males and females are sensitive to strong changes in light intensity during the earlier phases of courtship but not during the tail-straddling phase or during spermatophore deposition and recovery.

Sex Recognition and Aggression

Courting males use both olfactory and visual means to locate other salamanders. When the other salamanders in the container are motionless, the male moves around the container touching his nasolabial pro-

jections to the substrate repeatedly until he comes into close contact with another salamander. As soon as this occurs, he begins to undulate his tail laterally and attempts courtship. When one or more other salamanders are actively moving in the container, the male reacts visually and rapidly approaches them without the use of his nasolabial projections. In this kind of a situation, the tail of the male begins to wag when the male is several inches away from the salamander being approached. The courting male approaches both females and other males while undulating his tail and attempts courtship with either sex. The salamander being approached, however, reacts in one of several ways. If the salamander is a female, she either flees or remains passive. If, on the other hand, the one being approached is another male, he either flees or immediately bites the approaching male viciously on the legs and undulating tail. The courting male usually retreats immediately but occasionally a fight may develop with both males repeatedly biting one another.

On several occasions, during the month of September and prior to observing any courtship activity, two males were seen fighting. They invariably bit one another on the legs, head, or tail. Usually one of the males retreated after a short period of time and the other pursued him around the container. Occasionally, a nearby female was bitten by one or both of the combatants, probably accidentally.

The captive males did not establish definite territories. In September, direct contact between males usually resulted in fighting. During the courtship period in the month of October, however, the mere sight of a male wagging his tail was sufficient to cause another male to rush across the container at him and bite him on the legs and tail.

Spermatophore

Five spermatophores were deposited while courtship activity was under observation. In three of these depositions, one on October 9–10 and two on October 20–21, courtship was interrupted by the observer to examine the spermatophore. In the other instances, both on October 19–20, the female was allowed to pick up the sperm cap of the spermatophore. The stalk of a spermatophore was found on the morning of October 11 and two more were found on the morning of October 20. The last two were in addition to the stalks removed during the night of October 19–20 after their caps had been picked up by females under observation.

The three complete spermatophores were almost identical, and while the description is based on the one deposited at 1:29 A.M. on October 10, it is equally applicable to the two spermatophores collected during the night of October 20–21 (Figure 3).

The spermatophore in gross appearance is mushroom shaped. Oriented in terms of the body of the male depositing it, the cap is bilaterally symmetrical and compressed laterally. It is pale yellow and has a concavity on each side of the midline of the anterior surface. These two concavities give the anterior surface of the cap a "pinched" appearance. The posterior, dorsal, and lateral surfaces are smoothly rounded.

The supporting jelly-like stalk is colorless, glass-like, and greatly compressed. In profile, it is similar to that of *Plethodon jordani metcalfi* (Organ, 1958) but is more compressed and is actually a thin wedge. When freshly deposited, the surface of the stalk has both vertical and horizontal striations, the former more deeply incised than the latter. Its base flares outward to form a firm surface of attachment. The stalk has a cusp or spike that projects upward into the center of the cap.

The sperm cap is adhesive and clings to almost anything with which it comes in contact but the stalk is less adhesive. The cap is easily detached from the stalk and is the only part of the spermatophore picked up by the cloacal lips of the female during courtship. After detachment from the stalk, the sperm cap retains its characteristic shape and the cavity into which the stalk had projected remains open.

Discussion

The nest site of *P. welleri* is apparently restricted to rotten conifer logs. The egg mass with its attachment is similar to that found in *Plethodon cinereus* (Piersol, 1910, 1914; Cochran, 1911) and in *Plethodon glutinosus* (Highton, 1956). The number of eggs in a clutch is like that of *P. cinereus* (Piersol, 1910; Cochran, *op. cit.*). The obvious advantages of a small clutch of eggs in a terrestrial situation have already been pointed out by Piersol (1910).

The hatching sequence, beginning at the periphery of the mass, may be the result of a poorer oxygen supply and probably a greater accumulation of metabolic waste products at the center. Certainly the young salamanders that emerge from the central

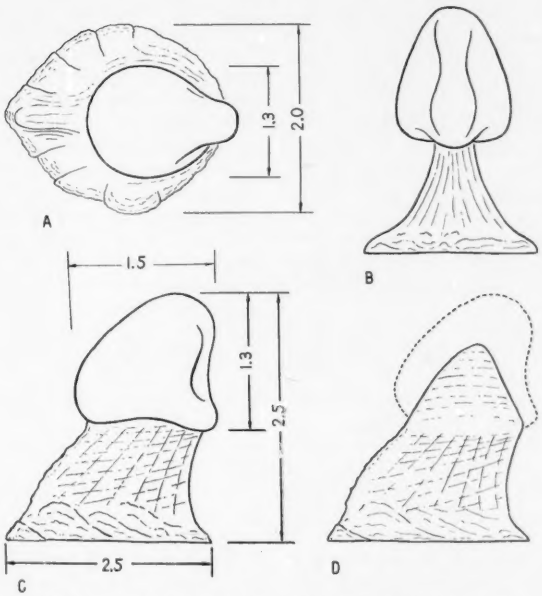

Fig. 3. The spermatophore of *Plethodon welleri*. A. Dorsal view. B. Anterior view. C. Right lateral view. D. Right lateral view of spermatophore stalk with position of sperm cap indicated by dotted line. Measurements in millimeters.

eggs are retarded in development. Even if conditions of captivity are such that the clutches hatch prematurely, which is unlikely, this differential development cannot be ignored.

The three egg masses collected on August 16 were remarkably similar in development, and the two clutches reared in captivity hatched within a few days of one another. The young from these clutches, reared in captivity, were similar in size and development to recently hatched young found in the field at comparable dates and were smaller and less well-developed than those found at slightly later dates. This suggests that the egg production period of this species is very short.

Studies on the local distribution of *P. welleri* in the Mount Rogers-Whitetop Mountain area of Virginia, which are still in progress, indicate that this species is not entirely restricted to the spruce-fir forests of the area but is, nevertheless, a high altitude form with a restricted altitudinal distribution.

A species such as *P. welleri*, restricted to the tops of the mountains in this area, has a shorter season for courtship and egg laying than one with a more extensive altitudinal distribution or one confined to lower altitudes. It is unlikely that natural selection could result in a more rapid development, particularly since the temperatures are lower at the higher elevations. Selection has more likely shortened the laying period itself so that most of the eggs can complete their development.

The recently hatched young of *P. welleri* and the later stages of the embryos of that species are distinguished from the other small species of the genus occurring within its geographical range by having a lower number of costal grooves. Indeed, the costal groove count is the only characteristic that distinguishes the embryos of *P. welleri* from those of the unstriped color phase of *P. cinereus* (UMMZ 110861). The striped color phase of *P. cinereus* (UMMZ 110861 and AMNH A54447) develops the stripe in the late embryo stage and is easily distinguished. The embryos of *P. glutinosus* (AMNH A23041) that were examined were at an earlier stage of development than the *P. welleri* and *P. cinereus* material but nevertheless had dorsolateral spotting, a condition absent in the embryos of *P. welleri*. The dor-

sal brassy pattern of fused spots which forms after the loss of gills also serves to distinguish the young of *P. welleri* from those of the other species of the genus occurring within its geographical range.

As in the majority of plethodontid salamanders, the attending females do not forage for food during the brooding period. The females probably do not leave the vicinity of the eggs until sometime after the young hatch and disperse from the nest. The young apparently remain in the nest after hatching until the yolk supply is almost exhausted and then disperse.

The courtship pattern of *P. welleri* is strikingly different from the preliminary phases of courtship in *P. j. metcalfi* (Organ, 1958) and of *P. glutinosus* (Organ, 1960). The male of *P. welleri* does not engage in a foot dance nor does he periodically raise his head, breaking contact between his mental gland and the skin of the female and snapping his head upward. The absence of head raising on the part of the male may be attributed to the reduction of the mental gland area in *P. welleri*. The absence of a foot dance in this species may be attributed to the general limb reduction characteristic of most of the smaller species of *Plethodon*. Since the foot dance is such a characteristic part of the preliminary courtship phases in the larger species of *Plethodon,* it would be interesting to know what the situation is in *P. cinereus,* which has also undergone limb reduction. The lateral tail undulations of *P. welleri* in the early phases of courtship also serve to distinguish between this pattern and that for the larger species of *Plethodon* in which the tail is not undulated until the male comes in contact with the chin of the female. Possibly the tail undulations of the male have replaced the foot dance in the pattern of the larger species of *Plethodon* as a method of sex recognition.

The courtship patterns of *P. welleri* and *P. j. metcalfi* both differ from that of *P. glutinosus* in that the male never grasps the body of the female with his mouth.

The shorter duration of the tail-straddling phase of courtship in *P. welleri,* as well as the high incidence of spermatophore recovery by the females, probably is attributable to this smaller species being less confined than were the larger species of *Plethodon* in the 8 inch glass finger bowls (Organ, 1960).

Practically nothing is known about sex recognition in plethodontid salamanders, but it has been suggested (Organ, 1960) that the aggressive reactions of males of *P. glutinosus* when approached by courting males may serve to identify sex. The similar aggressive reaction on the part of males of *P. welleri,* when approached by courting males, serves to strengthen this contention. Males of *P. welleri* attempted to court both females and other males. The tail-wagging was the same regardless of which sex was being approached by a courting male. Finally, aggressive clashes developed between males in every instance of contact but never between males and females.

The spermatophore of *P. welleri* has the same basic structure as that of *P. j. metcalfi* and *P. glutinosus* (Organ, 1958, 1960) but differs from both in having a very much reduced anterior lip on the sperm cap near its junction with the stalk and in being generally smaller. The cap is further distinguished by having a "pinched" anterior surface. The stalk resembles that of *P. j. metcalfi* in profile but is more compressed. The stalk differs from that of *P. glutinosus* in not having a mound of jelly behind the posterior border of the cap. Aside from these minor, but constant, differences, the spermatophores of these species are basically similar. In all three, the stalk has a cusp or spike projecting into the center of the cap. When detached from the stalk, the cap does not collapse and the cavity into which the stalk had projected remains open. Finally, the cap is the only portion of the spermatophore picked up by the cloacal lips of the female.

Summary

The dates of egg deposition for *Plethodon welleri* have not been determined but eggs with well-developed embryos were found on Mount Rogers, Virginia on August 16, 1958.

The egg mass, individual eggs, and nesting sites are described in detail.

Two egg clutches, reared in captivity, hatched between August 19 and August 24. Recently hatched young were found in nests with their attending females on August 18, August 30, and September 5.

The late embryos, hatching process, and recently hatched young are described and figured.

The courtship season is late in the fall. The courtship pattern was observed on several occasions in recently captured salamanders during the month of October.

The pattern of courtship is described in

detail and compared to that of *Plethodon jordani metcalfi* and *Plethodon glutinosus.*

Courting males do not distinguish between the sexes but sex recognition is accomplished by behavioral responses on the part of the salamander being approached. Aggressive clashes develop between males but not between males and females.

The spermatophore of *P. welleri* is distinct, but, in general, resembles that of *P. j. metcalfi* and *P. glutinosus.*

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Reproductive Cycle in Females of the Greater Earless Lizard, *Holbrookia texana*

Clifford Johnson

Cagle (1950) reported that *Holbrookia texana* lays several egg clutches per season, and that dissected oviducal eggs hatched after a 50 day incubation period. He was not able to locate a laid egg clutch. Smith (1946) states that the clutch size varies from 8 to 12; however no source of his data is given. The objective of this paper is to report a study of the gonads of 208 females of *H. texana* from a population inhabiting the shale ledges along the Clear Fork of the Trinity River, Tarrant County, Texas. For a more complete habitat description see Ramsey (1946).

Methods

Samples of 12 females were collected on 14 different dates from March 16, 1954 to August 9, 1954, when the observations were discontinued. All females were preserved within one hour after collecting. In addition, 28 females ranging from 60 to 69 mm. snout-vent were available for the winter months of December and January of 1953–1954. A sample of 12 females was collected on August 12, 1954, from a population at Mary's Creek, Tarrant County, Texas, and over 20 miles distant from the Clear Fork habitat.

Ovaries were examined by 4×, 7.5×, and 10×, and oocytes, follicles, and corpora lutea were measured for the greatest diameter with the aid of the camera lucida. The oocytes were readily distinguished from the follicles by their larger size and bright yellow yolk. The ovarian scars resulting from ovulation will be regarded here as corpora lutea following Nelsen (1953) and no implication of a hormonal action found in mammals is made. Oviducal eggs were measured with a vernier caliper. Means given in the text are accompanied by twice their standard errors.

Follicle Size and Number

The follicle number ranged from 8 to 24 per ovary (mean of 14 ± 3.3), and did not change over the time interval of study, including the female sample for the winter months. No correlation was found between follicle number and the presence of oocytes, oviducal eggs, or the snout-vent measurement of the females. Follicle size range was 0.3 to 1.9 mm. Follicles over this entire range were present in the winter sample as well as in the samples taken from March to August.

Oocytes and Oviducal Eggs

The oocyte number ranged from 4 to 9, with a mean of 5 ± 0.8 per individual for

946 oocytes. In only 8 individuals was the number of oocytes different in the left and right ovaries. No oocytes were present in the winter sample. All females collected from March 16 to August 12 possessed oocytes. The greatest diameter of oocytes per individual varied depending on the presence or absence of oviducal eggs. In the absence of oviducal eggs, the oocytes ranged from 5.1 to 9.2 mm. with a mean of 6.8 ± 0.6 mm. When oviducal eggs were present, the oocytes ranged from 3.2 to 4.6 mm. with a mean of 3.8 ± 0.3 mm. There was no overlap in the ranges of the greatest diameter of the oocytes under these two conditions.

The oviducal eggs ranged in number from 3 to 9 with a mean of 5 ± 0.06. The number fluctuated very little throughout the study period, (Fig. 1). The oviducal eggs ranged in greatest diameter from 10.0 to 13.9 mm. with a mean of 11.9 ± 0.06 mm. The oocytes apparently ovulate between 9.2 to 10.9 mm. which is the gap between the largest oocyte and the smallest oviducal egg. The greatest diameter of the egg is apparently 13.0 to 14.0 mm. when laid.

Of the 180 females collected from March 16 to August 12, 79 (39.9 percent) possessed oviducal eggs. There was no significant change in the numbers possessing oviducal eggs throughout the study interval.

Corpora Lutea

No traces of corpora lutea were found in females collected in December and January. The corpora lutea fell into two distinct size groups as the corpora lutea from earlier ovulations were being absorbed and becoming smaller. The larger group ranged in greatest diameter from 1.4 to 6.0 mm. with a mean of 2.3 ± 0.08 mm. The smaller group ranged in greatest diameter from 0.3 to 0.9 mm. with a mean of 0.5 ± 0.01 mm.

The large group of corpora lutea within an individual in all likelihood corresponds to the most recent ovulation in that individual. There is no evidence of differential rates of absorption of corpora lutea for successive ovulations, while there is substantial evidence that the most recent ovulation is related to the largest existing corpora lutea in an individual in other vertebrates (Nelsen, 1953). It appears safe, therefore, to assume that the large corpora lutea also represent the most recent ovulation in *H. texana*. The number of oviducal eggs resulting from the ovulation should therefore correspond to the number of large corpora lutea for the in-

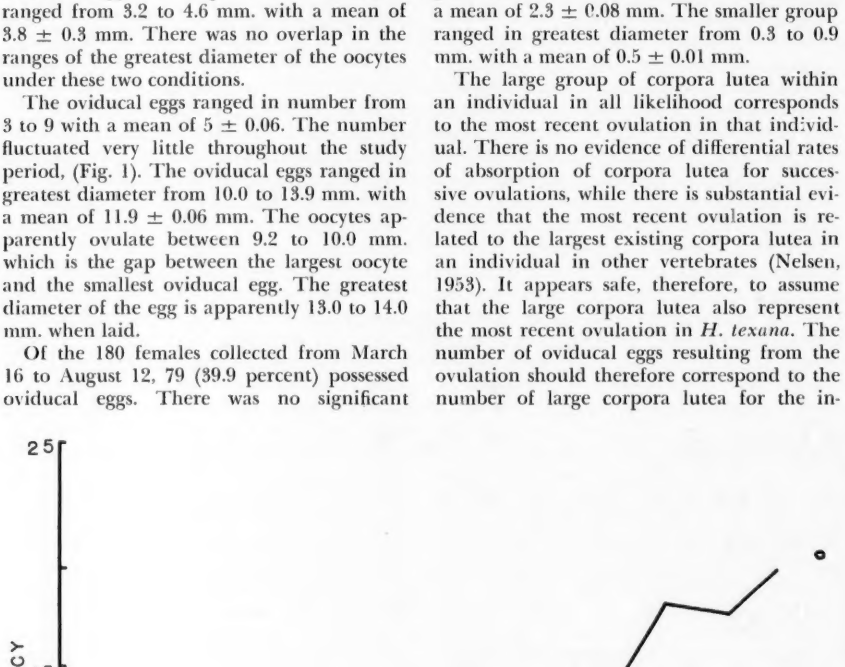

Fig. 1. Mean values of corpora lutea number and oviducal egg number. The solid line represents corpora lutea and the dashed line represents oviducal eggs. The two circles are the mean values for the Mary's Creek population.

dividual. Of the 79 individuals with oviducal eggs, 48 had the same number of corpora lutea as eggs in the oviduct, while 21 had fewer eggs. These 21 had 1 to 3 eggs less per oviduct than the number of large corpora lutea for the corresponding ovary.

The small corpora lutea were bright orange, which may represent a concentration of the lutein pigment. Each of these small corpora lutea was a discrete nodule. Figure 1 shows the increase of the number of corpora lutea through the study interval. I have no evidence that some were not completely absorbed toward the end of the observation period, though I saw no visible indication of their distintegration. Therefore the total number of corpora lutea is taken to represent the total number of eggs laid per individual prior to collecting. Complete absorption of the corpora lutea appears to occur over the winter's hibernation. The number of oviducal eggs reabsorbed is considered negligible.

Discussion

Follicles are apparently present in the ovaries throughout the year, and the corpora lutea are completely absorbed during the winter's hibernation. The gap of 1.0 mm. in the size distribution between the largest follicle and the smallest oocyte suggests that the maturation of a follicle is a rather fast transition.

The period of time the eggs remain in the oviduct is not known. However, while the eggs are in the oviducts, another set of oocytes matures. The first date an individual was collected having corpora lutea and no oviducal eggs was on April 24, 1954, which indicated oviposition had started. Egg-laying was continued at least until August 12, 1954.

If the oocytes present in each individual are to form the next clutch, then their mean number should correspond to that of the clutch mean. The mean number of oocytes was 5 ± 0.08, that of oviducal eggs 5 ± 0.06. The agreement of the two means is taken as evidence that the oocytes present at any one time are the forerunners of one future clutch.

On August 9 the mean number of corpora lutea was 20 ± 2.0, indicating 4 egg clutches (of 5 ova each) per individual at that date. All females collected on that date had well developed oocytes, indicating at least one more clutch. No information suggests absorption of the oocytes. The most likely number of clutches per female is therefore at least 5.

To maintain a stable population size, only 8 per cent of the oviducal eggs of a female producing 5 egg clutches of 5 eggs each would be required to live to adult breeding size. As selection certainly eliminates many females before they lay so many eggs, a much higher percentage of the next generation would be provided by the females that lived. Such an extended period of oviposition aids the survival of the species by providing higher percentages of the subsequent generations from parents that have survived environmental resistance longer. No difference in clutch size and consequent reproductive potential could be associated with the female's size and thus indirectly with her age.

The intensive collecting in the Clear Fork population might alter the reproductive behavior of those left. Figure 1 shows the close similarity of the Mary's Creek population to the Clear Fork group. Apparently no abnormal response was being made because of the removal of the Clear Fork females.

The 21 females that had fewer oviducal eggs than large corpora lutea suggest an adaptive behavior. I have never been able to locate a laid egg clutch, but on 3 occasions I have found a single egg 1 to 2 inches beneath shale. Two of these eggs hatched into *H. texana*. Probably *H. texana* females have solved the initial dispersal problem of the young by not laying all eggs of a clutch together. Aggregated groups of young so often encountered with lizards that do deposit egg clutches as in *Sceloporus* were never seen.

Juveniles were first seen on July 1. Cagle (1950) lists females of 51.7 mm. as juvenile. On August 9 I collected 3 females 48 mm. snout-vent, all of them having 5 or 6 large oocytes. The sizes of these oocytes fell within one standard deviation of the mean of oocyte size in the adult samples. These three females had no corpora lutea. They were most certainly of that summer's hatch as no females below 53 mm. were observed in the earliest available samples. It thus appears that they can lay during their first season.

Summary

An examination of the ovaries and oviducts of 208 females of *Holbrookia texana* was made over a time interval from March 16, 1954, to August 12, 1954, and from a sample collected in the winter of 1953–1954.

The mean follicle number was 14 ± 3.3 per individual and did not change over the study interval. The mean oocyte number was 5 ± 0.08 and the greatest diameter of the oocytes per individual was significantly larger when oviducal eggs were absent than when

the latter were present. The oocytes present are taken as the forerunners of the next clutch, and a new set of oocytes mature while eggs are still in the oviducts. The size of the oocyte at ovulation is between 9.2 and 10.0 mm.

The mean number of oviducal eggs per individual was 5 ± 0.06 with very little fluctuation over the study interval. The size of the egg when laid is between 13.0 and 14.0 mm. The number of corpora lutea steadily increased over the observation period and there was no evidence of complete absorption during this time interval. From the mean number of oviducal eggs, which is taken as the mean clutch size and the number of corpora lutea present, the number of clutches per individual prior to collection was estimated. For an individual that survives the whole season five clutches of eggs each, or a total of 25 eggs per individual is possible. Since the females which live longer leave more individuals to the following generations, the extended period of oviposition is given as a mechanism to select succeeding generations to higher adaptive levels in addition to providing a high basic natality.

The female appears to have solved the initial problem of the dispersal of the young by not laying all eggs of a clutch together, but over a widely scattered area. Indirect evidence suggests that young females may lay eggs in the same summer in which they hatched.

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A Redefinition of the Genus *Smilisca*

Priscilla Starrett

In 1865 Cope established the genus *Smilisca* for *Hyla baudini* Duméril and Bibron. He characterized the genus by "an elongate acuminate flat postorbital process of the frontoparietal bone" (1865:194). Many later authors, including Stejneger and Barbour (1943), continued to use the name *Hyla baudini*. Smith and Taylor (1948:75) reaffirmed the generic distinctness of *H. baudini* because of "pecularities in the skull of this species combined with the paired vocal sacs". The genus *Smilisca* is still not universally recognized and the species has been called a *Hyla* by many recent authors including Schmidt (1953).

In the course of studies on the jaw musculature of Anura, several interesting facts were uncovered regarding *Smilisca*. In some groups of frogs, including *Smilisca* and the hylid genera *Triprion, Diaglena, Pternohyla, Phyllomedusa, Phrynohyas* and *Cryptobatrachus*, two muscles arise from the anterior arm of the squamosal and insert on the lateral face of the mandible (Fig. 1). One muscle, the *adductor mandibulae posterior subexternus* lies medial to the mandibular branch of the trigeminal nerve ($N.V_3$), and the other, the *a. m. externus superficialis* lies lateral to the same nerve. In *Hyla* (except *H. aurea*) as well as *Pseudacris, Acris, Plectrohyla, Ptychohyla, Sphaenohyla* and *Hylella* the *a. m. externus superficialis* is absent in both the adult and the tadpole (Fig. 2).

Another muscle, the *depressor mandibulae*, in *Smilisca* also differs from that in *Hyla*. In *Smilisca* there are two distinct slips, one originating from the dorsal fascia and the other from the posterior edge of the posterior squamosal arm (Fig. 1). This condition occurs in other hylid genera including *Triprion, Diaglena, Anotheca, Gastrotheca,* and *Cryptobatrachus*. The general condition in *Hyla* is that in which the depressor originates from the fascia only, although the anterior part may lie on the squamosal (Fig. 2).

Further investigation of the osteology of *Smilisca* brought out several additional points. The shape of the squamosal in *Smilisca* is quite distinctive. The posterior arm is wide in a lateral direction (Fig. 3). The

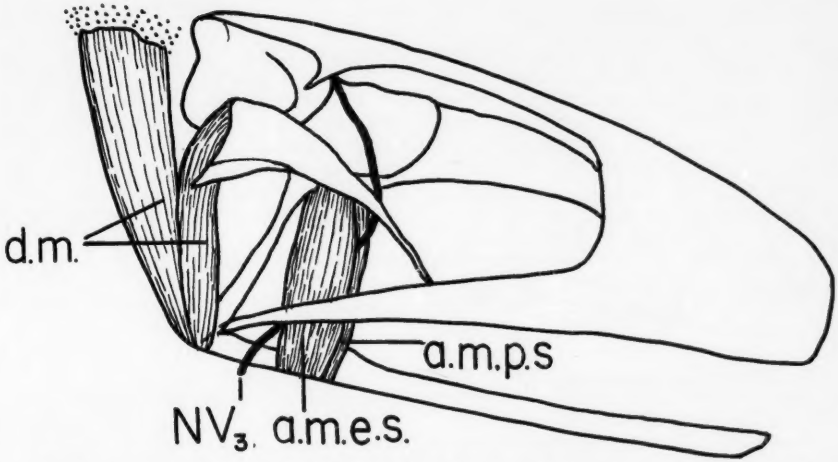

Fig. 1. Lateral view of the head of *Smilisca baudini* showing jaw muscles mentioned in the text. a.m.e.s., *adductor mandibulae externus superficialis*; a.m.p.s., *adductor mandibulae posterior subexternus*; d.m., *depressor mandibulae*; $N.V_{.3}$, mandibular branch of trigeminal nerve.

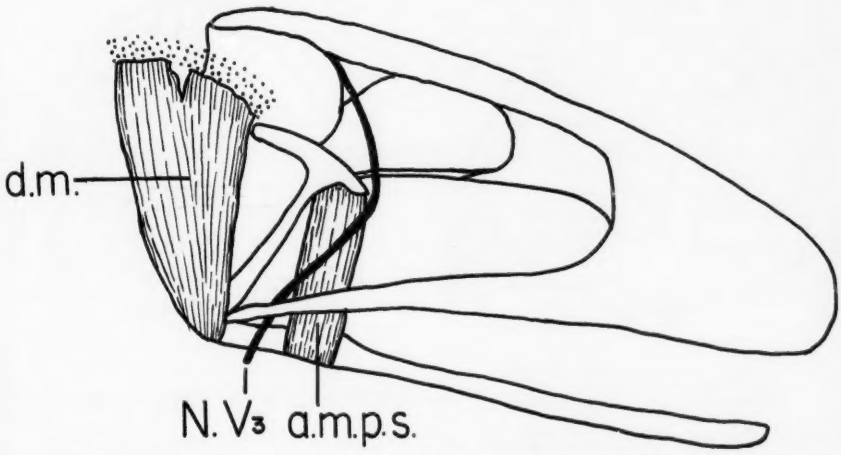

Fig. 2. Lateral view of the head of a *Hyla* showing jaw muscles mentioned in text. Abbreviations as in Fig. 1.

lateral edge of the anterior and posterior arms of the squamosal frequently has a wavy, bumpy outline that occasionally can be noticed externally. The anterior arm of the squamosal is long and contacts the maxilla.

The large xiphisternum in this genus is ossified and the omosternum is partly ossified in some specimens.

A frontoparietal foramen is present in *Smilisca* but is smaller than it usually is in *Hyla*. The anterior blades of the frontoparietal are wider in *Smilisca* and there is more ossification posteriorly.

These characters added to the presence of a frontoparietal process support the recognition of *Smilisca* as a distinct genus.

In examining the jaw musculature of adults of 42 species and tadpoles of 13 species of *Hyla*, I noticed that 3 species differed from the normal *Hyla* condition in possessing an *a. m. externus superficialis* and a depressor with a slip on the squamosal as

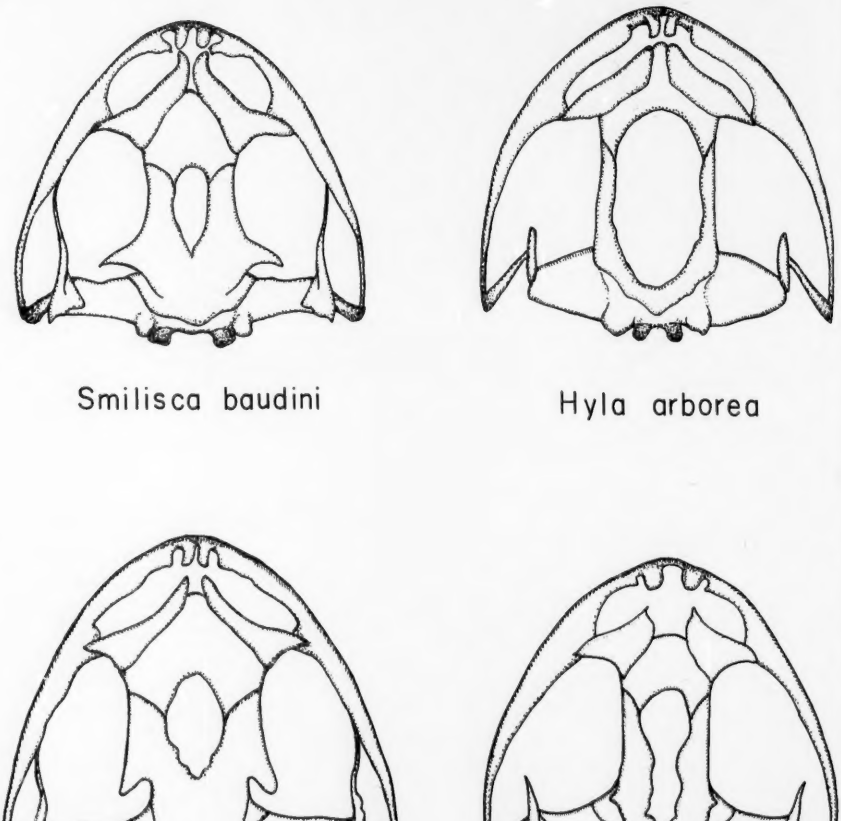

Fig. 3. Dorsal views of skulls of *Smilisca* compared with that of *Hyla arborea*.

well as the fascia. These three species are *H. phaeota* Cope, *H. gabbi* Cope and *H. wellmanorum* Taylor. These frogs show a similarity to *Smilisca* in the other characters as well. The bony postorbital process found in *S. baudini* also occurs in *H. phaeota* and is suggested in *H. gabbi* and *H. wellmanorum* (Fig. 3). The process in *H. phaeota* is well developed although not laterally directed as in *S. baudini* but it is parallel to the fronto-parietal. In *H. gabbi* and *H. wellmanorum* there is no projecting process but the fronto-parietal does have a lateral flange in this area. This can be discerned in cleared and stained specimens.

The shape of the squamosal is the same in these 3 species as it is in *S. baudini*. The anterior arm of the squamosal contacts the maxilla in *H. phaeota*. In *H. gabbi* and *H. wellmanorum* there is a tendinous connection between the anterior squamosal arm and the maxilla.

The xiphisternum is calcified in all specimens of these three species which I have ex-

amined, and the omosternum shows calcification in all the specimens of *H. gabbi* and *H. wellmanorum* and in some *H. phaeota*.

The frontoparietal foramen is small in *H. phaeota* and the anterior portion of the frontoparietal is wider in this species than in *S. baudini*, *H. gabbi* or *H. wellmanorum*. The foramen in *H. gabbi* and *H. wellmanorum* tends to be larger and extend farther posteriorly but is not as extensive as in most other *Hyla*.

Smilisca baudini is said to have paired vocal sacs. This species has essentially a median subgular sac. The median aponeurosis of the mylohyoid muscle constricts the sac somewhat to produce two bulges and the skin of the throat is modified in such a way as to emphasize these bulges. The sac is continuous and is not divided into two separate completely lateral sacs as in *Phrynohyas* (Duellman, 1956) and many ranids. This tendency toward lateral bulging of a subgular sac occurs in *H. phaeota*, *H. gabbi* and *H. wellmanorum* as well, but there is no median constriction of the muscle or modification of the throat skin. There is more pigment on the sides of the throat in these species and this tends to emphasize the lateral bulges. I have observed all four species calling in the field. This tendency toward lateral bulging of a subgular sac also occurs in several other hylids, such as *Pternohyla*, *Hyla dominicensis*, *H. septentrionalis* and *H. pseudopuma* (Liu, 1935). The sacs in *H. pseudopuma* are more laterally placed than they are in *Smilisca baudini*.

The tadpoles of *S. baudini* (Stuart, 1948: 26) and *H. phaeota* are generalized, having sinistral spiracle, dextral vent, and 2/3 tooth rows. The presence of the *a. m. externus superficialis* in these tadpoles is useful in distinguishing them from generalized *Hyla* tadpoles.

Because of the presence of the aforementioned characters, the species *Hyla phaeota*, *H. gabbi* and *H. wellmanorum* should be included in the genus *Smilisca*. The genus may now be defined as follows:

Genus *Smilisca* Cope

Genotype: Hyla baudini Duméril and Bibron.

Generic diagnosis: Hylid frogs distinguished by the following combination of characters: frontoparietal with a bony postorbital process; posterior arm of squamosal wide, anterior arm long, contacting maxilla with a bony or tendinous connection; *M. add. mand. externus superficialis* present; *depressor mandibulae* muscle consisting of two distinct slips, one arising from the dorsal fascia and the other from the posterior squamosal arm; vocal sac with tendency toward lateral bulging.

Species: Smilisca baudini (Duméril and Bibron), range Texas to Costa Rica; *Smilisca phaeota* (Cope), range southern Mexico to northern South America; *Smilisca gabbi* (Cope), range Costa Rica and Panamá; *Smilisca wellmanorum* (Taylor), range Costa Rica.

Smilisca phaeota and *S. baudini* form one species group having the large frontoparietal process and squamosal-maxillary contact. *S. gabbi* and *S. wellmanorum*, with skulls extremely similar in appearance, seem most closely related to each other and form a second group. It is possible that other frogs currently recognized as *Hyla* may be found to belong to the genus *Smilisca*.

The more specialized, semi-fossorial hylid, *Pternohyla*, may be related to *Smilisca*. Young specimens of *P. fodiens* have a postorbital bony process almost identical with that of *S. baudini*. In adult *Pternohyla* the process is enlarged and rugose and contributes to the "casque-head" of this species. The origin and insertion of the *depressor mandibulae* in *Pternohyla* is like that of *Smilisca* and both the *a. m. posterior subexternus* and *a. m. externus superficialis* are present. The vocal sac has the tendency toward lateral bulges, also. *Pternohyla*, however, has no frontoparietal foramen and the head skin in adults is fused to the frontoparietal bone. The posterior arm of the squamosal is not especially enlarged, although the anterior arm is long and contacts the maxilla.

Species Examined

Smilisca baudini, *Hyla andersoni*, *H. arborea*, *H. aurea*, *H. bistincta*, *H. bromeliacia*, *H. brunnea*, *H. cinerea*, *H. crepitans*, *H. crucifer*, *H. dominicensis*, *H. elaeochroa*, *H. ewingi*, *H. eximia*, *H. femoralis*, *H. gabbi*, *H. gratiosa*, *H. heilprini*, *H. lichenata*, *H. loquax*, *H. marianae*, *H. miotympanum*, *H. misera*, *H. moraviensis*, *H. ocularis*, *H. phaeota*, *H. phlebodes*, *H. pseudopuma*, *H. pulchrilineata*, *H. punctata*, *H. raddiana*, *H. raniceps*, *H. regilla*, *H. rubra*, *H. septentrionalis*, *H. squirella*, *H. uranochroa*, *H. vasta*, *H. versicolor*, *H. wellmanorum*, *H. wilsoniana*, *H. weyerae*, *Acris gryllus*, *An-*

otheca coronata, Cryptobatrachus fuhrmani, Diaglena spatulata, Gastrotheca marsupiatum, Hylella sumichrasti, Nototheca pygmaea, Phrynohyas spilomma, Phyllomedusa boliviana, P. callidryas, P. dacnicolor, P. helenae, P. moreleti, Plectrohyla guatemalensis, P. sagorum, Pseudacris nigrita, P. streckeri, Pternohyla fodiens, Ptychohyla spinipollex, Sphaenohyla planicola, Triprion petasatus.

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Summary

Comparison of *Hyla baudini* Duméril and Bibron with other members of the genus *Hyla* shows differences which warrant recognition of *Smilisca* Cope (genotype: *Hyla baudini)* as a distinct genus with the following characters: frontoparietal with a bony postorbital process; posterior arm of squamosal wide, anterior arm long, contacting maxilla with a bony or tendinous connection; *M. adductor mandibulae externus superficialis* present; *M. depressor mandibulae* consisting of two distinct slips, one arising from the dorsal fascia and the other from the posterior arm of the squamosal; vocal sac with a tendency towards lateral bulging. On the basis of these characters three other species described as *Hyla* also belong in the genus *Smilisca: S. phaeota* (Cope), *S. gabbi* (Cope), and *S. wellmanorum* (Taylor). Morphologic evidence suggests that *Pternohyla* may be related to *Smilisca.*

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A New Salamander of the Genus *Chiropterotriton* from Chiapas, Mexico, with Notes on Related Species

George B. Rabb

THROUGH the courtesy of Hobart M. Smith I have examined a small series of an undescribed plethodontid salamander of the genus *Chiropterotriton* from the state of Chiapas, Mexico. Since little has been published on the other representatives of the genus from the territory between Panama and Isthmus of Tehuantepec, Mexico, comments on them and comparative data on the two closest relatives of the new species are included in the following account. The nature of the measurements and techniques used are covered in a previous paper on the northern taxa of the genus (Rabb, 1958).

In reference to the spectacular size of the nostril in adults, the new form may be known as:

Chiropterotriton megarhinus, sp. nov.

Fig. 1, bottom

Type.—University of Illinois Museum of Natural History No. 40782, an adult male collected by Thomas MacDougall on February 1, 1957, on the northern slopes of Cerro Tres Picos, about 19 kilometers northeast of Tonala, Chiapas, Mexico. Altitude approximately 7000 feet.

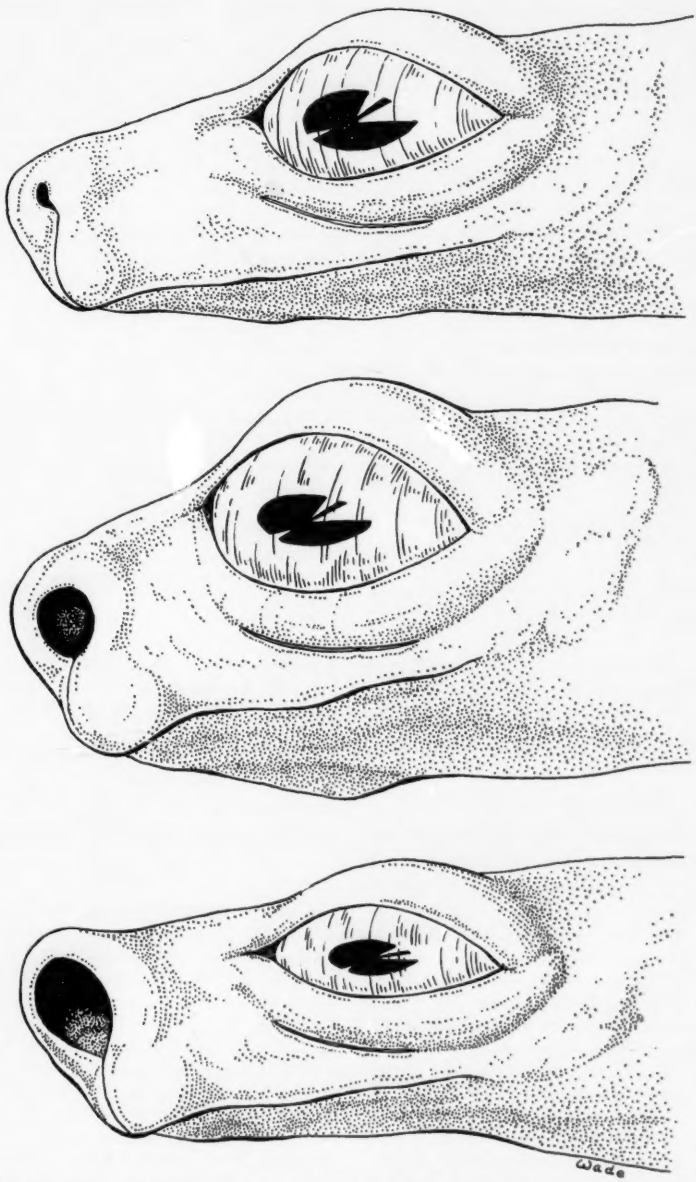

Fig. 1. Heads of adult specimens of three species of *Chiropterotriton* from the Sierra Madre of Chiapas and Guatemala. *Top, C. xolocalcae,* CNHM 91482, a female paratype from Cerro Ovando; *Middle, C. bromeliacia,* CNHM 20693, a male paratype from Volcan Tajumulco; *Bottom, C. megarhinus,* UIMNH 40782, the type male from Cerro Tres Picos.

TABLE 1. DATA ON INDIVIDUALS OF *Chiropterotriton megarhinus* AND RELATED SPECIES*

	xolocalcae			*bromeliacia*			*megarhinus*							
	CNHM 75709	UIMNH 10087	CNHM 100199	CNHM 20693	CNHM 20294	CNHM 20294	UIMNH 40782	UIMNH 40783	UIMNH 40780	UIMNH 40777	UIMNH 40781	UIMNH 40779	UIMNH 40778	UIMNH 40784
Sex	♂2	♂1	♀	♂2	♂1	♀	♂2	♂2	♂1	♀	♀	♀?	♀?	?
Snout-vent	35	25	26.5	32	27	24.5	33	32	25	26	23	20	19	12
Tail	39	27	26.5	35.5	30	23.5	39	—	30	24	29	20	20	9
Head width	5.8	4.7	4.3	4.8	4.5	4.2	5.5	4.5	4.8	4.3	4.3	3.6	3.6	2.5
Snout-gular fold	8.9	6.7	6.7	7.6	6.7	5.8	8.3	7.7	6.2	6.2	6.1	4.9	5.2	3.0
Snout-jaw angle	6.2	5.0	4.2	5.1	4.8	4.2	5.9	5.5	4.5	4.6	4.6	3.6	3.6	2.2
Snout-eye	2.1	1.5	1.5	1.6	1.5	1.2	1.9	1.8	1.5	1.6	1.5	1.2	1.1	.65
Eye width	1.9	1.6	1.5	1.9	1.6	1.6	2.0	2.0	1.6	1.6	1.7	1.5	1.5	1.0
Nostril width	.17	.20	.20	.55	.55	.60	.85	.75	.65	.65	.70	.65	.60	.45
Internarial	2.2	1.6	1.5	1.6	1.5	1.0	1.4	1.4	1.0	1.0	1.0	.80	.75	.50
Limb interval	0.5	1.0	1.5	2.0	2.0	2.0	0	0	1.5	0.5	1.5	1.5	2.0	1.0
Vomerine teeth	21	17	16	6	10	9	10	9	14	16	12	11	11	9
Maxillary teeth	52	45	45	35	30	37	50	49	48	44	42	22	24	—
Dentary teeth	74	61	63	62	49	46	70	73	59	50	58	—	—	—

Measurements in mm. Subscript of male symbols indicates number of testis lobes. Limb interval is expressed in costal spaces between ends of adpressed limbs.

Paratypes.—UIMNH 40777-81, 40783-4, same collection data as the type.

Diagnosis.—A medium-sized, slender species with a large number of maxillary teeth in males, distinguished by its extremely large nostrils on a normal but elongate snout, and long legs (which meet when adpressed in adult males).

DESCRIPTION OF TYPE

General aspect of body slender (this impression heightened by desiccative preservation). Tail noticeably longer than body. Head length to side of gular fold contained in body length about four times, head width in body length nearly six times. Distance from angle of eye to tip of snout about one-third that from snout to angle of lower jaw. Narial openings very prominent, with greatest width more than one-half the minimum internarial distance. Nasolabial protuberances apparently fairly well developed.

Maxillary-premaxillary teeth (both sides) 50, three of the large ones on premaxillary piercing the lip. Mandibular teeth 70; vomerine teeth 4 on right and 6 on left side, in short curves separated by one choanal diameter. Two well-separated patches of teeth on the posterior vomerine shelf, numbering about 42 in each obovate group. Sublingual fold not well developed. Anterior ends of ceratohyals spatulate, not participating in the fold.

Legs meet when pressed to the sides. Postiliac gland small, weakly developed. Digits rather broad at tips; webbing variable, greater on limbs of left side; almost entire left fifth toe attached, whereas terminal and part of penultimate phalanges on corresponding right toe are free.

Color of dorsum in alcohol dark brown, except for some darker and light mottling along the middle of the back and tail. Venter a dirty cream (melanophores widely spaced).

VARIATION

The type series is so small that I have presented the quantitative data for all the specimens in Table 1 along with data for selected individuals of *C. bromeliacia* and *xolocalcae*. The specimens of *C. megarhinus* were shrunken slightly more than is normal by preservative. The type and one paratype (40783) are the only adults of the older age classes, as judged from their bilobate testes. UIMNH 40780, snout-vent length 25 mm., has pigmented unilobate testes and a papillate vent, but the mental gland cluster is indistinct. The largest female, snout-vent 26 mm., shows no enlargement of the ovarian eggs.

Noteworthy features shown in Table I are the increase of nostril size with body size, and the concomitant apparent decrease in number of vomerine teeth indicated by the

counts of the two mature males (see Figs. 2–4).

Although there is some variation in the width of the digits and in the amount of webbing, for the most part it does not exceed that between the two sides of the type. Generally the webbing is attached near the middle of the penultimate phalange. The outer digits have particularly full webbing in most of the specimens.

Color pattern range is great. Ground color of the dorsum varies from a dark brown with lavender overtones to a light tan. The rostral area is light in three of the eight specimens. Two of these three and two others have a sharply defined whitish anterior interocular bar. Most of the series show some indication of a dark triangle with base between the eyes and apex where the anterior mandibular levators meet. Two specimens have striking light dorsolateral stripes running from the posterior corner of the upper eyelid to the tail tip. One of these has dark blotches or dashes contained within or along the margins of the stripes. Postpelvic diagonal dashes of light color (perhaps yellow or orange in life) are evident in half the series. The venter is heavily pigmented in the smallest specimen, slightly less in the two adult males, and a great deal less in the others.

Habitat

According to the collector, the type series of *C. megarhinus* was taken from large terrestrial bromeliads (either *Tillandsia grandis* or *Vtiesia werckliana*) containing water. These were situated in somewhat dwarfed cloud forest within a thousand feet of the summit of Cerro Tres Picos. No salamanders were taken within the elfin facies of the cloud forest, in which heaths and myrtaceous shrubs were associates of the trees and where stunting was more pronounced due to fuller exposure to northerly winds.

Relationships

The species of *Chiropterotriton* north of the Isthmus of Tehuantepec may be separated as a group from those to the south on the basis of the presence of the septomaxillary and prefrontal elements of the skull. The former is a primitive character for any plethodontid found south of the United States, and the prefrontal I consider primitive in *Chiropterotriton*.

C. megarhinus appears most closely related to its nearest neighbors among the southern *Chiropterotriton*, *C. xolocalcae* of Cerro Ovando, Chiapas, and *C. bromeliacia* of Volcan Tajumulco, Guatemala. It mainly differs

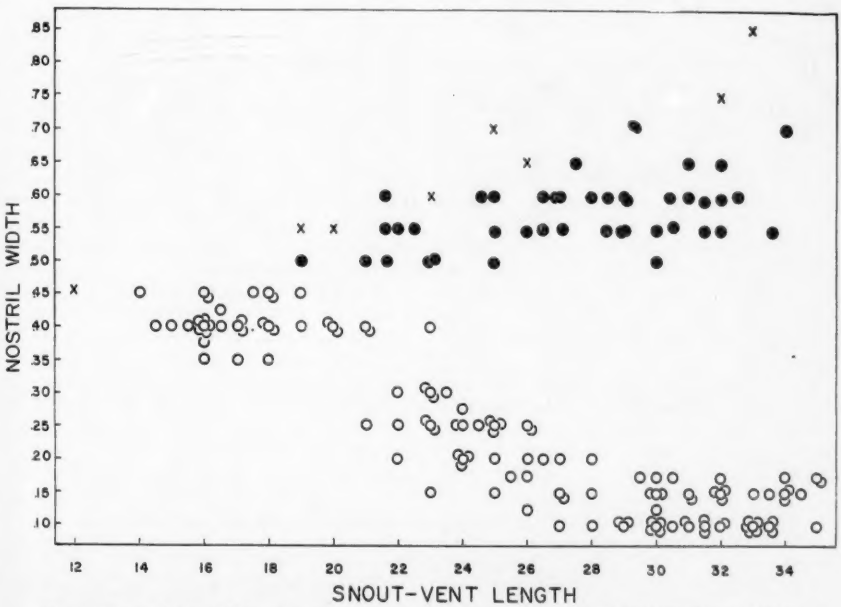

Fig. 2. The relation of nostril size to body size in three species of *Chiropterotriton*. Circles, *C. xolocalcae*; black discs, *C. bromeliacia*; crosses, *C. megarhinus*. Measurements in mm.

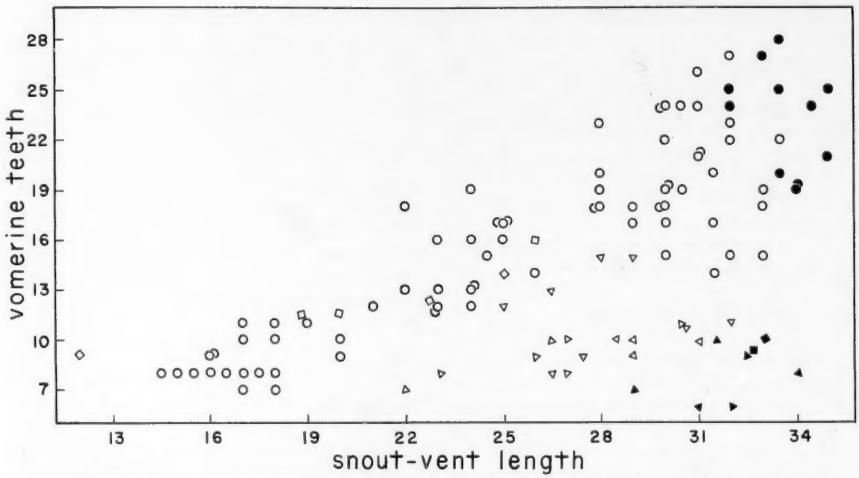

Fig. 3. The relation of number of vomerine teeth to body size in three species of *Chiropterotriton*. Round symbols, *C. xolocalcae*; triangles, *C. bromeliacia*; squares, *C. megarhinus*. The entire series of *C. megarhinus* is included but only males of *C. xolocalcae* and *bromeliacia*. Black symbols denote males with bilobate testes.

from *xolocalcae* in having an increase of nostril size and a decrease in number of vomerine teeth with increasing body size (Figs. 2 and 3). Greater enlargement of the nostril distinguishes it from *bromeliacia* (Fig. 2), but it chiefly differs from this species in having longer legs and more maxillary and dentary teeth (Fig. 4).

The maximum width datum used to indicate nostril size in Fig. 2 does not give a full picture of the variation since the nostril is differently shaped at different widths. In *C. xolocalcae* the change from young to adult is striking; for example, areas represented by widths of 0.45, 0.30, and 0.15 mm. stand in ratio relationship as 36:16:3. The areal nostril differences in large adults of the three species can be appreciated from Fig. 1. The specialized condition of large nostrils in adults is also found in the Honduran species *C. nasalis* and the Costa Rican form *C. picadoi*.

The presence of a discrete submentalis (anterior intermandibularis) muscle, spatulate anterior ends of the ceratohyal cartilages, and entirely separate nasal processes of the premaxilla are internal features common to *C. xolocalcae, bromeliacia, megarhinus* and the northern species of *Chiropterotriton* but not to the southern species *nasalis, picadoi,* and *abscondens*.

The anterior palatal pit mentioned by Taylor (1948, 1952) in his descriptions of *C. abscondens* is also prominent in *C. picadoi*. It occurs in a less developed form in some specimens of *C. nasalis*. From Inez Wilder's account (1925:86), the pit is an enlargement of the internasal gland opening, which is presumably possessed by all plethodontids.

The features of coloration described for *C. megarhinus* are found in both close relatives (see illustration and description of *bromeliacia* by Schmidt, 1936, and of *xolocalcae* by Taylor, 1941). The occurrence of light markings in the series examined of the three species is given in Table II. At least some of the markings occur in *C. nasalis, picadoi,* and *abscondens*. They are also found in some northern species of *Chiropterotriton*, but generally are not in so great contrast with background coloration.

If the small nostril in adults of *C. xolocalcae* is primitive, as I believe, the geographic position of this species between *C. megarhinus* and *bromeliacia* argues against a simple linear allopatric differentiation of the genus as it moved southward. The pattern of speciation for the southern *Chiropterotriton*, in light of the distribution of the characteristics mentioned above, reflects a single invasion from the north followed by at least two radiations in the new territory.

Remarks

Seasonal changes of size and number of premaxillary teeth have been recorded in

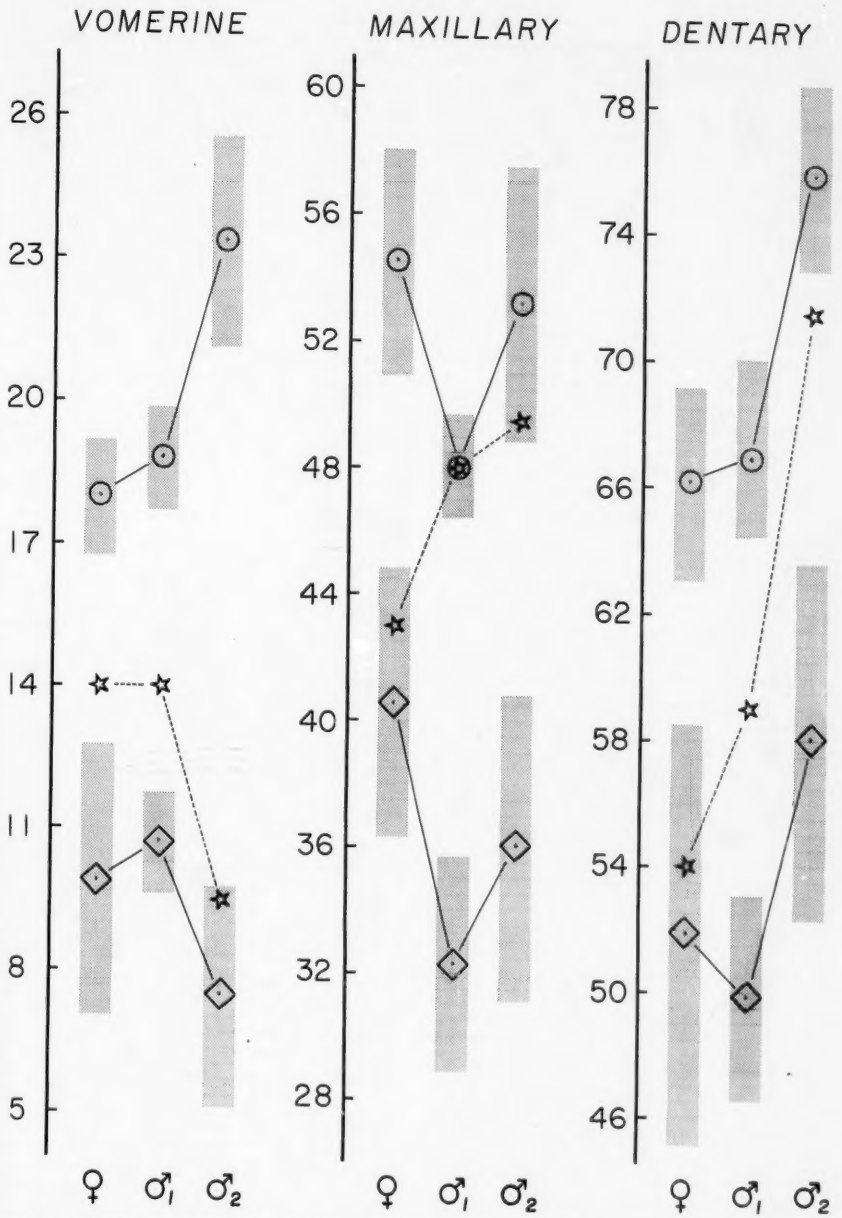

Fig. 4. Tooth count data for *Chiropterotriton bromeliacia* (squares), *xolocalcae* (circles), and *megarhinus* (stars). For first two species symbols indicate means, gray rectangles represent 95% confidence limits of standard errors of these means ($t_{.05}s_{\bar{x}}$). For *C. megarhinus* symbols represent data from the five largest specimens (see Table I and text). Subscripts of male class symbols indicate number of testis lobes.

TABLE 2. FREQUENCY OF LIGHT MARKINGS IN THREE SPECIES OF *Chiropterotriton*

	megarhinus	*xolocalcae*	*bromeliacia*
Individuals	8	144	44
Rostral	3	22	8
Interocular	4	132	42
Dorsolateral	2	7	2
Postpelvic	3	123	37

male *Eurycea bislineata* by Stewart (1958). Although her paper does not present data on seasonal changes in number of maxillary and dentary teeth, it does suggest that they occur. If this source of variation were present in *Chiropterotriton*, it would severely reduce the taxonomic usefulness of numerative dental characteristics, which are already complicated by sex and maturation differences. The only material of *Chiropterotriton* offering evidence on this important point are series in the University of Michigan Museum of Zoology of *C. chondrostega cracens* (collected from March to September) and lowland series of *C. chiropterus* (January to August). I can find no certain evidence of seasonal change in the few males of equivalent age classes in these series. It is assumed for the present that this indicates little or no seasonal change in *Chiropterotriton*.

The teeth are apparently under various hormonal-ontogenetic controls, since there may be drastic reduction (*C. chiropterus*), slight reduction (*C. multidentatus*), or continued addition (*C. chondrostega cracens*) in the maturing males (Rabb, 1958). The data on teeth of *C. megarhinus, xolocalcae*, and *bromeliacia* indicate that in some species the sets of teeth may respond in different ways (Fig. 4). The numbers of maxillary and dentary teeth are nearly the same in *megarhinus* and *xolocalcae*, but the vomerine numbers diverge from what may be considered the normal mean of 15–16 in adults of species with similar maxillary and dentary counts. *C. xolocalcae* shows continued addition with increasing size in the adults, *C. megarhinus* appears to show reduction (Fig. 3). For *C. bromeliacia* the data more definitely indicate a reduction in the vomerine sets of the larger males. There is otherwise continued addition in the number of teeth in both sexes.

Only in the southern species of *Chiropterotriton* is large nostril size in adults not associated with other paedomorphic features (especially of the feet), such as those found in *Thorius, Parvimolge townsendi*, and *Chiropterotriton dimidiatus*. As with the teeth, developmental controls are probably not simple, judging from the different growth trends of *C. xolocalcae, megarhinus*, and *bromeliacia* (Fig. 2). Observations by Organ (1958, 1960) on two species of *Plethodon* indicate that olfaction may play a great role in mating behavior, or at least in specific recognition as Noble and Brady (1930) contended. Accordingly, the differences in nostril size among the southern species of *Chiropterotriton* may be functionally significant and may be correlated with differences in courtship patterns.

Similarly, the interspecific variation in the palatal opening of the internasal gland suggests that differences may be found in the feeding behavior of southern *Chiropterotriton*, if the gland provides a sticky secretion that enables the tongue to secure prey (Wilder, 1925:86; Dunn, 1926:19). It may be possible to discern such differences through analysis of stomach contents.

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CHICAGO ZOOLOGICAL GARDENS, BROOKFIELD, ILLINOIS.

Food of Larval and Young Tarpon, *Megalops atlantica*[1]

R. W. HARRINGTON JR.[2] AND E. S. HARRINGTON

A STUDY of the diet of tarpon as small as most of those considered here has not hitherto been possible for want of such early stages. Soon after the first validated record of transitional or metamorphic larvae of *Megalops atlantica* Valenciennes (Harrington, 1958), Gehringer (1959a) described the first leptocephalus known of this species, a single individual found 150 miles off the coast of Georgia. As is not unexpected, by analogy with other fishes undergoing such metamorphosis, e.g. *Elops saurus* Linnaeus (cf. Gehringer, 1959b) this leptocephalus is larger (18.0 mm. in standard length) than several of the transitional stages referred to above. The present study is based on the original series of tarpon collected in 1956 (Harrington, 1958) supplemented by additional material, mostly taken from the same salt marsh but during other years. The earlier paper (Harrington, 1958) should be referred to for details of the ecological background and of the morphometry of successive stages.

It is perhaps significant that of all of the extensive fish collections made by the senior author and his co-workers in this region (Indian River and St. Lucie counties, on the Florida east coast) between 1954 and the present, small tarpon are confined to those made in salt marshes and mangrove swamps between early August and mid-October. Although no special effort was made to define the local incidence of small tarpon, these collections sample a variety of shallow-water habitats throughout the calendar year. Gehringer's leptocephalus was taken on August 5, and the single 20–mm. specimen of Hildebrand (1934), subsequently lost but identifiable in retrospect as a transitional larva (Harrington, 1958), was taken on August 21, in the mouth of Core Creek, Beaufort, North Carolina. The records of the earliest stages of tarpon reported so far are thus confined to three autumn months, which enhances interest in the food habits during the same months of these diminutive inshore migrants.

MATERIALS AND METHODS

The standard-length (S. L.) frequencies and dates of collection of the 472 tarpon dissected are shown in Table 1. All but 53 specimens (August 9, 1954 and September 9, 1955 collections) came from the same salt marsh. The smallest 35 individuals include one 16 mm. in S. L., ten, 17 mm., eight, 18 mm., nine, 19 mm., and seven, 20 mm. The series begins with mid-metamorphic larvae, and progresses through early young tarpon. It will suffice to recall that scale primordia first appear at about 30 mm. S. L., and that the progress of lepidogenesis and of other morphological changes has been equated with successive lengths up to 60 mm. S. L. (Harrington, 1958).

All specimens were fixed in 10 percent formalin, washed in water, and stored in 70 percent ethyl alcohol. After the conventional measurements were made (cf. Harrington, 1958), the entire alimentary tract was removed, and transferred to a vial of 70 percent alcohol. The contents of the whole gut were identified under dissecting and compound microscopes as required. The percentage contributed by each food item to the total con-

[1] Contribution No. 91, Entomological Research Center, Florida State Board of Health, aided by grant No. 5415, National Institutes of Health, U. S. Public Health Service.

[2] Principal investigator.

TABLE 1. THE STANDARD-LENGTH DISTRIBUTIONS OF THE TARPON, *Megalops atlantica*, IN EACH COLLECTION[1]

Standard Lengths in mm.	1954	1955		1956					1957	Totals
	Aug. 9	Sept. 1	Sept. 9	Sept. 10–12	Sept. 17–18	Sept. 28	Oct. 1–2	Oct. 10	Sept. 4–6	
16–20		2		13	6	1	6	3	4	35
21–25		2	15	14	5	35	14	9	2	96
26–30		7	14	5	10	22	20	4	1	83
31–35	2	10	9		7	6	4	4		42
36–40		9	7		5	2	3	10		36
41–45	2	7				2		4		15
46–50	2	1	1			1	2	3	3	13
51–55							1	1	8	10
56–60					1	1			20	22
61–65		1			1				34	36
66–70		1						1	27	29
71–75					2				23	25
76–85		1				2			13	16
86–157		1	2				1		10	14
Totals	6	42	48	32	37	72	51	39	145	472

[1] Aug. 9 and Sept. 9 tarpon were from ditches of two different mangrove swamps; all other tarpon were from the same high *Batis-Salicornia* salt marsh.

tents of each gut taken as 100 percent was estimated with the aid of a 0.5 mm. grid printed on a photographic emulsion on the underside of the thin glass bottom of a shallow liquid-tight tray with lucite sides. The entire contents were then returned to the vial pending the next step in the procedure.

Before the contents were transferred in alcohol to a centrifuge tube for volumetric measurement, the larger particles were teased into small fragments. To speed sedimentation, the tube was gently centrifuged, and occasionally it was necessary to prod the sedimented mass in the lower part of the tube with a fine wire and to re-centrifuge in order to eliminate lacunae. Bauer-Schenck, Blue Line "Exax" centrifuge tubes, calibrated to 0.004 ml., were used for the smaller volumes. Of necessity, the lower portion of these tubes is narrow, and at first could not be cleaned out. This difficulty was overcome by diverting some water from the main flow through a tap into stainless steel hypodermic-needle tubing. The incurrent opening of the steel tubing was projected diagonally into the main flow through a hole drilled in a reduction nozzle screwed into the tap. The excurrent tip of the steel tube was bevelled to a sharp point like that of a hypodermic needle, and a long straight terminal segment of the tube was bent toward the vertical. The clogged centrifuge tube was slipped upside down over the steel tube until its blind end rested on the pointed excurrent tip. When the centrifuge tube is rotated in this position, its contents are washed out quickly and completely by the fine jet of water, and when the tap is turned off, the resulting back pressure in the steel tube removes by aspiration any water trapped in the tip of the centrifuge tube.

The percentages contributed by the constituent food items as estimated on the grid were converted to parts of the total volume as measured in the calibrated centrifuge tube. The volumes of any item or combination of food items so computed could then be summed for all fish of the same standard-length range, same date, etc. To assure accuracy of computation, the total of the sums of all constituent items was checked against the sum of the measured total volumes; and the data arranged by fish length-classes were checked against the same data arranged by collection dates. In a review of the different methods of food measurement, Hynes (1950), who favors the quick but subjective "points method", has shown convincingly that most methods give substantially the same final results, and that refinements in measurement may give a semblance of greater accuracy than is warranted by the degree of subjective inaccuracy unavoidable by the taxonomist confronted often with fragments of partly digested organisms. In the present study, the total contents of the tract were measured volumetrically to set an upper limit to the subjective error inherent in taxonomic identification and percentage estimate against a grid. The two critical and related operations, identification and estimation, were made the responsibility of the same person, the junior author; the other phases of the work were accomplished by the senior author or under his close supervision.

SYNOPSIS OF FOOD

With one exception (Table 3), only the gut contents of 442 tarpon 16-75 mm. S. L. will be considered, since the remaining 30 larger tarpon (cf. Table 1) encompass unevenly a wide range of standard lengths, and are of less interest because of their size. In the synopsis of food items, by frequency of occurrence in 442 tarpon and by percent volume of their collective gut contents (Table 2), four important items emerge from the list

of organisms ingested. In order of importance these are: cyclopoid copepods, 72.80% of the total volume, fishes, 22.29%, caridean shrimp of the genus *Palaemonetes*, 2.99%, and *Aedes* mosquitoes, 1.24%, of which about 96% were *A. taeniorhynchus* and 4%, *A. sollicitans*. The remaining 0.32% of the total volume was composed of detritus (0.10%), of nine more items (0.21%) present in measurable amounts in the following order of decreasing volumes: undetermined crustacean fragments, harpacticoid copepods, notonectids, stratiomyids, mites, ostracods, gammarideans, coleopteran fragments, and psocopterans, and of 17 trace items (0.01%).

In general, there is positive correlation between high percent frequency of occurrence and high percent volume. Cyclopoid copepods lead all items on both accounts. Most copepod eggs and nauplii (Table 2) probably belong to cyclopoids, but this was not verifiable taxonomically; these occurred in many tracts but contributed little bulk. Harpacticoid copepods, although found in many tarpon, were mostly present in very small amounts (see below). Calanoid copepods occurred rarely and only in trace amounts. Caridean shrimp contributed appreciably to the aggregate food volume but were found in only 13 tarpon, no doubt partly as a consequence of their comparatively large size (see below); those intact enough for identification proved to be *Palaemonetes intermedius* Holthuis. Most of the few recognizable crustacean zoeae were crab zoeae, but some were *Palaemonetes* zoeae.

In considering the incidence of transitory forms such as saltmarsh mosquitoes (*Aedes* spp.), it should be kept in mind that the eggs are deposited on humid ground, only hatch upon flooding by rainfall or tidal fluctuation (directly after, at this latitude), and that within a rather short time interval, the ensuing brood traverses a succession of instars, pupates, emerges, and escapes from the aquatic environment. In more permanent waters, aquatic stages of multivoltine insects may persist with minor fluctuations in number through much of the year, but on salt marshes and in adjacent mangrove swamps conditions are less stable. Whether massive or peripheral, flooding can initiate saltmarsh mosquito broods, and their availability to fish predators probably varies with the amount and kind of searching required to capture the various instars. The minute first instars tend to appear in small scattered patches near where they hatched; later stages, although progressively reduced in numbers by mortality, are more conspicuous because of their greater size and tendency to coalesce in large aggregations; pupae remain at the surface more consistently than larvae, and are therefore more prone to stranding. Thus

TABLE 2. SUMMARY OF FOOD ITEMS IN THE GUTS OF 442 TARPON, *Megalops atlantica*, 16–75 MILLIMETERS STANDARD LENGTH

Food Item	Frequency of Occurrence		Volume	
	Number of Tarpon	Percent of Tarpon	Sum Total for All the Tarpon (Milliliters)	Percent of the Sum Total Volume of All Items
Plant remains	12	2.7	Trace	—
Foraminifera	1	0.2	Trace	—
Rotifera	4	0.9	Trace	—
Bryozoa	3	0.7	Trace	—
Copepoda	435	98.4	18.2380	—
Eggs	415	93.9	Trace	—
Nauplii	136	30.8	Trace	—
Cyclopoids	430	97.3	18.2180	72.80
Harpacticoids	131	29.6	0.0200	0.08
Calanoids	10	2.3	Trace	—
Ostracoda	14	3.2	0.0121	0.05
Gammaridea	4	0.9	0.0100	0.04
Caridea: *Palaemonetes*	13	2.9	0.7488	2.99
Crustacean zoeae	20	4.5	0.0014	—
Crustacean fragments	7	1.6	0.0475	0.19
Psocoptera	5	1.1	0.0026	0.01
Thysanoptera	2	0.5	Trace	—
Hemiptera	5	1.1		
Notonectids	3	0.7	0.0190	0.08
Fragments	2	0.5	Trace	—
Coleoptera	2	0.5	0.0020	—
Curculids	1	0.2	Trace	—
Fragments	1	0.2	0.0020	0.01
Hymenoptera	9	2.0		
Chalcidoids	4	0.9	0.0004	—
Fragments	5	1.1	Trace	—
Diptera	104	23.5	0.3317	—
Culicids: *Aedes*	73	16.5	0.3092	—
1st instar	13	2.9	0.0115	0.05
2nd instar	1	0.2	0.0014	0.01
3rd instar	4	0.9	0.0055	0.02
4th instar	14	3.2	0.2908	1.16
Fragments	52	11.8	Trace	—
Chironomids	30	6.8	Trace	—
Ceratopogonids	1	0.2	Trace	—
Stratiomyids	2	0.5	0.0140	0.06
Insect fragments	92	20.8	0.0012	—
Acarina	45	10.2	0.0120	0.05
Arthropod fragments	121	27.4	Trace	—
Fishes	135	30.5	5.5804	22.29
Detritus	8	1.8	0.0259	0.10
Empty	1	0.2	—	—
Total (percent)				99.99
Trace Items (percent)				0.01
Sum Total Volume of All Items (Milliliters)			25.0245	

TABLE 3. PERCENT FREQUENCIES OF OCCURRENCE OF FOOD ITEMS IN 472 TARPON, *Megalops atlantica*, BY COLLECTION DATE[1]

Food Item	1954	1955		1956					1957
	Aug. 9	Sept. 1	Sept. 9	Sept. 10–12	Sept. 17–18	Sept. 28	Oct. 1–3	Oct. 10	Sept. 4–6
Plant remains		2.4	4.2	3.1	8.1				4.1
Foraminifera			2.1			1.4			
Rotifera			2.1			1.4			1.4
Bryozoa		2.4	2.1					2.6	
Copepoda	33.3	95.2	95.8	100.0	100.0	100.0	98.0	94.9	93.8
Eggs	33.3	95.2	95.8	78.1	97.3	100.0	90.2	79.5	90.3
Nauplii	16.7	38.1	4.2		37.8	81.9	56.9	15.4	6.2
Cyclopoids	33.3	95.2	95.8	100.0	97.3	100.0	96.1	92.3	92.4
Harpacticoids	16.7	69.1	2.1	9.4	16.2	38.9	66.7	35.9	11.7
Calanoids		4.8	12.5			2.8			
Ostracods		4.8							9.0
Gammaridea						1.4			2.1
Caridea									
Palaemonetes		2.4					2.0		17.9
Crustacean zoeae		19.0			13.5	8.3	2.0		
Crustacean fragments		2.4							4.1
Collembola									0.7
Psocoptera				3.1	2.7	4.2			0.7
Thysanoptera		2.4				1.4			
Hemiptera	33.3		4.2			1.4			3.4
Corixids						1.4			0.7
Notonectids	33.3								0.7
Gerrids			4.2						0.7
Fragments									1.4
Coleoptera							2.0		2.1
Curculids									0.7
Hydrophilids							2.0		0.7
Fragments									0.7
Hymenoptera									6.2
Chalcidoids									2.8
Fragments									3.4
Diptera		11.9	2.1	43.8	73.0	15.3	23.5	2.6	26.9
Culicids: *Aedes*		7.1		43.8	73.0	15.3	23.5	2.6	4.1
Dolichopodids			2.1						
Chironomids		2.4							22.1
Ceratopogonids		2.4							
Stratiomyids									2.1
Insect fragments		9.5	4.2	12.5	43.2	65.3	5.9		15.2
Acarina				12.5	37.8	25.0			6.2
Arthropod fragments		23.8	12.5	9.4	32.4	26.4	15.7	7.7	42.8
Fishes	50.0	45.2	20.8		24.3	6.9	31.4	46.2	57.9
Detritus			2.1	3.1	2.7	2.8	2.0		2.1
Empty									0.7
Nos. of Tarpon	6	42	48	32	37	72	51	39	145

[1] See footnote of Table 1.

the time of fish sampling with reference to the hatching and progress of the mosquito brood is critical, and here (Table 2) no particular significance can be attached to the seemingly greater incidence of first and fourth instars in the aggregate volume or to the precise percent frequency and percent volume of *Aedes* mosquitoes, except for the fact that they were taken in important amounts. In passing, it may be be noted that one consequence of the ingestion of mosquito larvae by tarpon was the prevalence of larval mosquito setae piercing the walls of guts otherwise often devoid of mosquito remains. Among 15 other species of fish from the same collections, this condition was encountered only in mullet.

The fishes in the guts of the tarpon were usually in advanced states of dissolution, sometimes otoliths and eye-lenses alone remaining; the few amenable to identification were sailfin mollies, *Mollienesia latipinna* LeSueur, some evidently born recently. Some psocopterans were of the family Psyllipscocidae, and among the notonectid remains, *Buenoa scimitra* Bare was recognizable.

Food Analysis by Date

The percent frequencies of occurrence of food items among all 472 tarpon when recorded by date (Table 3) show that in general the same major items were favored during four succeeding years. As anticipated, there was much variability in the frequency of occurrence of *Aedes* mosquitoes. They were lacking altogether in those tarpon taken August 9, 1954 and September 9, 1955, in mangrove swamps, and although the other tarpon all came from the same marsh (cf. Tables 1 and 3), their gut contents reflect the changing availability of mosquitoes on different dates. The schedule of flooding in 1956 was carefully studied (Harrington, 1958), and an analysis of the progress of the mosquito brood as reflected in the guts of other fish species then entering that marsh is now in preparation. It may be noted here that in 1956 the previously dry marsh was massively flooded by combined tide and rainfall on September 9. This accounts for the high incidence of *Aedes* mosquitoes in tarpon sampled September 10–12 (Table 3), for the still higher incidence September 17–18, when great aggregations of chiefly fourth instar larvae were still present, and for the low incidence September 28, by which time the main brood had made its exodus from the marsh. The incidence again rises October 1–3, as a result of high tide October 1, which extended the perimeter of standing water, and hatched a smaller, secondary brood from eggs lying just beyond the periphery of the already flooded area. By October 10, this small brood was reduced in numbers and dispersed from the original egg sites.

The frequencies with which fishes and *Palaemonetes* shrimp were taken are functions of tarpon size (cf. Tables 1 and 3 and below). In the 1957 collection (Table 3), chironomids seem to have presented an alternative to mosquitoes. Raney and Webster (1940) found that only the head capsules of chironomids resisted digestion in stomachs of *Ictalurus* (*Ameiurus*), and for these they recorded estimated original volumes instead of actual volumes as measured. This expedient was unnecessary in the case of the tarpon, as the bodies also were frequently present, and in any case chironomids had a low percent frequency of occurrence (Table 2).

Effect or Tarpon Size on the Selection of Food

Volumetric analysis of the food ingested by the 442 tarpon 16–75 mm. S. L. (Fig. 1 and Table 4) disclosed a preponderant bias for cyclopoid copepods and fishes throughout this range in size. The combined volumes of the two items for the six successive 10-mil-

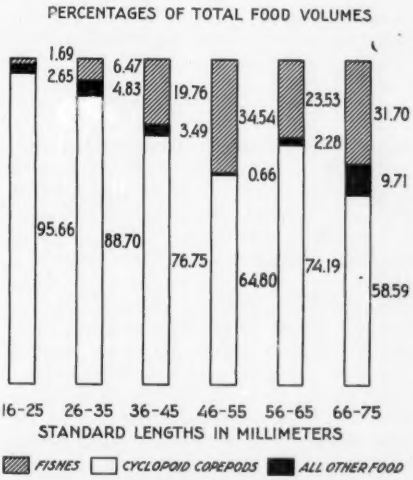

Fig. 1. Volumetric analysis by length-class of food items in the guts of 442 tarpon, *Megalops atlantica*. Compare with the data in Table 4.

TABLE 4. VOLUMETRIC ANALYSIS BY LENGTH CLASS OF FOOD ITEMS IN THE GUTS OF 442 TARPON, *Megalops atlantica*

Food Item[1]	Percentages of the Total Volumes of All Items					
	Standard Lengths in Millimeters					
	16–25	26–35	36–45	46–55	56–65	66–75
Copepoda						
Cyclopoids	95.66	88.70	76.75	64.80	74.19	58.59
Harpacticoids	1.48					
Ostracoda					0.15	0.02
Gammaridea			0.11			0.08
Caridea: *Palaemonetes*					1.82	8.56
Crustacean zoeae		0.01	0.03			
Crustacean fragments						0.65
Psocoptera	0.19					
Hemiptera						
Notonectids				0.66	0.10	
Coleoptera						
Fragments						0.03
Hymenoptera						
Chalcidoids						0.01
Diptera						
Culicids: *Aedes*	0.97	4.81	3.02			
1st instar	(0.46)	(0.09)	(0.05)			
2nd instar	(0.10)					
3rd instar	(0.41)					
4th instar		(4.72)	(2.97)			
Stratiomyids						0.02
Acarina			0.33			
Fishes	1.69	6.47	19.76	34.54	23.53	31.70
Detritus	0.01	0.01			0.01	0.34
Totals (percent)	100.00	100.00	100.00	100.00	100.00	100.00
Total Volumes of All Items in Milliliters	1.35	3.92	3.57	1.81	7.14	7.23
Numbers of Tarpon	131	125	51	23	58	54

[1] Items recorded in Table 5 but not here were present in trace amounts.

limeter standard-length ranges comprised, respectively, 97.35%, 95.17%, 95.51%, 99.34%, 97.72%, and 90.29% of the total volumes. In short, the percent volumes of the two items are complementary. With increasing tarpon size, the relative volume of fishes increases at the expense of the relative volume of cyclopoid copepods ingested. Between the two extreme length-classes (16–25 mm. and 66–75 mm.), the ratio of the percent volume of cyclopoid copepods to that of fishes changes from 95.66:1.69 to 58.59:31.70. A moderate deviation from this trend is restricted to the least sampled standard-length class (46–55 mm.), with only 23 individuals. It will be recalled (Table 2) that cyclopoid copepods constituted 72.80%, fishes, 22.29%, and their sum, 95.09% of the aggregate food volume of all 442 tarpon. There can be little doubt that both items were omnipresent irrespective of date or collecting site, and that the relative proportion in which they are ingested is the reflex of predator size.

The remaining food items are of subordinate importance, contributing but 0.66–9.71 percent volume (cf. black segments in the bar diagrams of Fig. 1 and data in Table 4). A few items made up these percent volumes; the rest occurred as traces. The changing percent volumes of some are chiefly attributable to predator size, of others, to transitory availability, but speculation is unprofitable in most cases because the invertebrates concerned have been little studied as to behavior, preferred microhabitat, fluctuations in numbers, etc.

Harpacticoid copepods were in trace amounts in all but those tarpon of the smallest length-class (Table 4), in which they made up 1.48% of the total volume. In that length-class, this brings to 97.14 the total percent volume of copepods, which are clearly the paramount dietary item of the earliest tarpon stages so studied to date. The smallest individual (16 mm. S. L.) and those just larger had eaten nothing but copepods. Each copepod occupied the whole cross-section of the slender gut, which runs along the ventral edge of the larval tarpon from head to vent. The senior author has found copepods in guts of *Elops saurus* leptocephali with lumina not noticeably greater in diameter, and on a diet of *Artemia* nauplii, he has reared to considerable size both an 18.1 mm. and a 19.0 mm. tarpon (for a comparison of early *Megalops atlantica* and *Elops saurus* stages, see Hildebrand, 1943, Figs. 1–3; Harrington, 1958, Fig. 5 and pl. 1; Gehringer, 1959a, Fig. 1; 1959b, Figs. 1–12). In sum, it is not unlikely that copepods are ingested also by the early-metamorphic larvae and by the leptocephali of tarpon. Psocoptera (bark lice) in more than trace amounts were also confined to the tarpon of the smallest length-class. These evidently fall into the water from the black-mangrove canopy and from other trees along the hammock line near which small tarpon were often seen, and where the smallest individual was captured individually as it swam at the surface of water a few inches deep.

Saltmarsh mosquitoes (instars 1–3) contributed 0.97% of the total food volume of the smallest length-class of tarpon. The disproportionate percent volume of second instar compared to those of first and third instars (Table 4) was probably the accident of collecting dates, as these stages are swiftly traversed, but fourth instar larvae were no doubt lacking because they were too big for these smallest tarpon to swallow. Mosquito larvae in more than trace percent volumes are confined otherwise to the next two larger tarpon length-classes (26–35 mm. and 36–40 mm.), and are predominantly fourth instar, the instar of the longest temporal duration on this marsh (cf. Christophers, 1960:246, concerning relative durations of *Aedes* instars) and perhaps of the most extensive aggregations. The absence of mosquito larvae in the remaining, larger tarpon (46–75 mm. S. L.), although somewhat the result of place and time of collection, was probably for the most part a function of their growing predilection for larger organisms.

Among the largest items taken were *Palaemonetes* shrimp. These were the prey only of those tarpon of the two largest length-classes (56–65 mm. and 66–75 mm.), whether analyzed by percent volume (Table 4) or by percent frequency of occurrence (Table 5). Notonectids also were restricted to guts of larger tarpon (cf. Tables 4 and 5). The percent volumes (Table 4) of ostracods, gammarideans, crustacean zoeae, coleopterans, chalcidoids, mites, and stratiomyids are doubtless mostly the accidents of time and

TABLE 5. PERCENT FREQUENCIES OF OCCURRENCE OF FOOD ITEMS IN 442 TARPON, *Megalops atlantica*, BY LENGTH CLASS

Food Item	Standard Lengths in Millimeters					
	16–25	26–35	36–45	46–55	56–65	66–75
Plant remains	0.8	3.2	2.0		3.4	7.4
Foraminifera		0.8				
Rotifera	1.5	0.8		4.3		
Bryozoa			5.9			
Copepoda	100.0	100.0	96.1	87.0	98.3	98.1
Eggs	93.9	96.8	90.2	73.9	96.6	96.3
Nauplii	40.5	52.0	25.5	13.0	3.4	
Cyclopoids	100.0	100.0	94.1	78.3	94.8	98.1
Harpacticoids	32.1	39.2	41.2	30.4	13.8	7.4
Calanoids	3.1	4.0	2.0			
Ostracoda	0.8		2.0		8.6	13.0
Gammaridea			2.0			3.7
Caridea: *Palaemonetes*					1.7	22.2
Crustacean zoeae		4.8	15.7		6.9	3.7
Crustacean fragments					5.2	7.4
Psocoptera	2.3	1.6				
Thysanoptera	0.8	0.8				
Hemiptera			2.0	4.3	3.4	1.9
Notonectids			2.0	4.3	1.7	
Fragments					1.7	1.9
Coleoptera						3.7
Curculids						1.9
Fragments						1.9
Hymenoptera					6.9	9.3
Chalcidoids					1.7	5.6
Fragments					5.2	3.7
Diptera	19.1	21.6	21.6	8.7	34.5	35.2
Culicids: *Aedes*	19.1	20.8	19.6	4.3	12.1	7.4
1st instar	11.5	4.8	2.0			1.9
2nd instar	1.5					
3rd instar	3.1	1.6	2.0			
4th instar		8.0	9.8	4.3	1.7	
Fragments	9.9	17.6	11.8	4.3	12.1	5.6
Chironomids			2.0	4.3	24.1	25.9
Ceratopogonids		0.8				
Stratiomyids					1.7	1.9
Insect fragments	20.6	26.4	21.6	4.3	12.1	24.1
Acarina	16.0	10.4	2.0		8.6	9.3
Arthropod fragments	11.5	20.8	27.5	39.1	56.9	44.4
Fishes	3.1	18.4	62.7	52.2	43.1	72.2
Detritus	0.8	0.8			1.7	3.7
Numbers of Tarpon	131	125	51	23	58	54

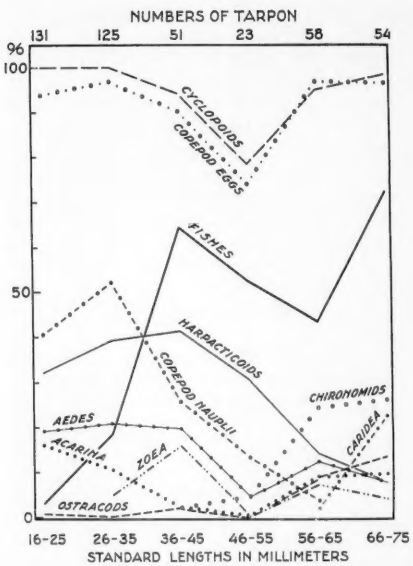

Fig. 2 Percent frequencies of occurrence of food items by length-class among 442 tarpon, *Megalops atlantica*. Compare with the data in Table 5.

place of collection, although some of these (cf. Tables 4 and 5) were mostly found in the larger tarpon.

The percent frequencies of occurrence of the food items by tarpon length-classes (Table 5 and Fig. 2), in addition to providing a check on the analysis of the same material by percent volume, record the incidence according to tarpon size of the trace items inaccessible to volumetric analysis. As in the introductory synopsis (Table 2), high percent frequencies of occurrence generally parallel high percent volumes (cf. Tables 4 and 5), but the essential trend in food selection (Fig. 1) is obscured by the welter of trivial items (Fig. 2). Further consideration of these trivial food items would be unrewarding because their biology is little known and because their contributions to the diet of small tarpon are minor.

Summary and Conclusions

The predominant food items of tarpon ranging in size from 16.0 mm. standard length (mid-metamorphic larvae) to 75.0 mm. (young-of-the-year), and to somewhat larger size, are cyclopoid copepods and small fishes. These two items, on the average, make up over 95% of the total volume of food throughout this range of tarpon sizes. At the small end of the range (16–25 mm. S. L.), copepods (cyclopoid, 95.66%; harpacticoid, 1.48%) make up about 97% of the total food volume, which points to the possibility that copepods are the staple of the early-metamorphic larvae and of the leptocephali as well. At the large end of the range (66–75 mm. S. L.), fishes make up about 32% and cyclopoid copepods about 58% of the total volume; the remainder (about 10%) is largely *Palaemonetes* shrimp, which are probably unavailable to the smaller tarpon because of their comparatively large size. At 10-millimeter intervals of standard length between the two extreme length classes considered, the sums of cyclopoid copepod plus forage-fish volumes vary between 95–98% of the total food volumes, but there is a remarkably consistent increase in the percent volumes of fishes, at the expense of the percent volumes of cyclopoid copepods. These two items appear to be omnipresent in the habitats studied, and to have become obligatory items of the small tarpon diet. The remaining organisms are either of more transitory occurrence in the habitat or of more transitory availability because of their respective definitive sizes. Chief among the subordinate, intercalary items on the menu of small tarpon locally are saltmarsh mosquitoes of the species *Aedes taeniorhynchus* and shrimp of the species *Palaemonetes intermedius*. The former are preferred by the smaller, and the latter are restricted to the larger tarpon of this size range, but both taxa are replaced by a moderate variety of alternative food organisms, as the availability of the two primary subordinate food items changes, either through fluctuations in their numbers or with the increasing capacity for larger organisms of the rapidly growing tarpon.

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Sperm Morphology of Two Cottid Fishes in Electron Micrographic Silhouettes

BERNARD D. FINK AND GLEN B. HAYDON

HANN (1930) described the shape of the sperm in 20 genera and 32 species of cottid fishes (actually only 13 genera according to Bolin, 1944). He further examined sperm of eight genera of various other families and concluded that there was a greater variation in the shape of the sperm within the Cottidae than in all the rest of the teleosts that he or others had studied. In this family he observed a gradation, with all possible transitional stages, from spermatozoa that were decidedly oval to those that were very slender. A phylogenetic tree based on gross morphological characters was constructed by Bolin (1947) for a large portion of the cottid group that Hann studied. There is an excellent correlation of sperm shape as described by Hann with the position the species occupy in this tree. It appears that the degree of phylogenetic relationship between any two species or groups of species (subgenera and genera) in this family is indicated by the degree of similarity of their sperm morphology. This supports the premise of Hubbs and Turner (1939) that "characters associated with reproduction are the most reliable indications of relationship". Hann's method of studying the sperm (sectioning the gonads of preserved specimens, staining, and light microscopy) were admittedly inadequate, and did not show variations between the closely related species.

This paper attempts to show some of the morphological differences between the spermatozoa of the two most closely related species in the genus *Oligocottus*, by study of electron micrographic silhouettes.

MATERIALS AND METHODS

Ripe male specimens of *Oligocottus snyderi* and *O. rubellio* were captured from tide-pools in the Monterey, California area during the winters 1958 and 1959. Semen was stripped from fishes and suspended in saline solution. The sperm was then washed in saline solution and spun down at full speed by an International Clinical Centrifuge in ½ ml. tubes for approximately two minutes. This was repeated three times. They were then resuspended in about ¼ ml. saline solution and an equal amount of two percent buffered osmic-acid solution was added. After five minutes fixation in this solution, the sperm were rewashed in distilled water. Small drops of the finally suspended sperm were placed on grids previously coated with a Formvar film and allowed to dry.

The preparations were studied with a Philips electron microscope model EM 75. Initial magnification on 35 mm. fine-grain positive film were approximately 600 and 2400 diameters. The pictures were subsequently enlarged for further study. Relative measurements were made from pictures taken on the same roll of film and processed together, so that they are quite accurate. The ease and accuracy with which ratios were calculated made them particularly useful in this study. On representative rolls of film the overall magnification was further calibrated with a standard carbon replica grating or with latex spheres.

GENERAL MORPHOLOGY

Hann has described the sperm of both *Oligocottus snyderi* and *O. rubellio* as "me-

dium slender", a designation which is as good as any. Those of *O. rubellio* are considerably larger than those of *O. snyderi*, measuring 53.0 microns in mean total length as against 38.6 microns. In both species they are composed of three major portions: head, mid-piece and tail (Fig. 1 and 2).

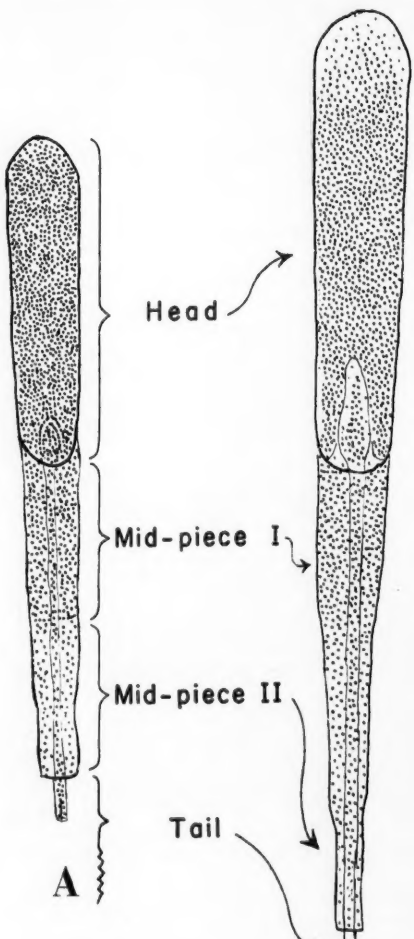

Fig. 1. Semi-diagrammatic drawing of head, mid-piece, and part of tail of sperm from: A. *Oligocottus snyderi*, and B. *O. rubellio*. Magnification approximately × 12,160.

Fig. 2. Sperm of *Oligocottus:* A. Entire sperm of *O. snyderi*, mid-piece I is distorted probably from osmotic imbalance (approximately × 2700); and B. Head and mid-piece of *O. rubellio* sperm (approximately × 10,000).

Head

The head region of the sperm of both the species studied is in the form of an elongate tapering rod with rounded ends. Those of *Oligocottus snyderi* are approximately 4 microns long, with their maximum width proximal to the anterior end. In *O. rubellio* the head is considerably longer, measuring approximately 5.5 microns. The head of *O. snyderi* tapers to a slightly greater extent than that of *O. rubellio*, the ratios of maximum to minimum width for *O. snyderi* being 1.3 and that for *O. rubellio* being 1.2. In addition, the ratio of head length to average head width for *O. snyderi* is 4.8 as compared to that of *O. rubellio*, 5.2. These differences make the head of *O. snyderi* appear slightly squatter than that of *O. rubellio*.

Mid-Piece

On the basis of general morphology and degree of distortability the mid-piece may be divided into two parts (Fig. 1). The anterior half although thicker is much more subject to variations during preparation, probably osmotic imbalance playing the major role (Fig. 2A). This part may be termed mid-piece I in order to distinguish it from the less electron-opaque part that usually appears as a sleeve covering the basal portion of the tail, mid-piece II. In outline the two portions of the mid-piece form in undistorted sperm an almost continuous taper. In *O. snyderi* the total lengths of the mid-pieces are something less than the head (Fig. 1A) while in *O. rubellio* they are nearly identical (Fig. 1B).

Tail

The ratio of the total sperm length to head length reflects the difference in total length of the sperm in these two species of fish (*O. snyderi* 7.4, *O. rubellio* 8.4). This seems especially noteworthy if one considers that the absolute length of the head of *O. snyderi* is less than that of *O. rubellio*.

Speculation

Most of the sperm examined show what appears to be a "sheath" of low density material covering at least the head and mid-piece, and occasionally the entire sperm. This may be the cell membrane, but there is a good possibility that it is adherent material. Neither bacterial silhouettes nor silhouettes of the sperm of non-cottid fishes as made with this method show anything similar to this. Unpublished research by the author has indicated that the sperm of *Oligocottus snyderi* may naturally retain their viability for three and one-half months or more on the modified epidermis of the genital region of the female; a position fully exposed to the external environment. This is in contrast to the condition in the cottid *Orthonopias triacis* postulated by Bolin (1941) who assumed, since he got repeated fertilization without intervening copulation, that the sperm were held in the oviduct (as in several viviparous fishes). This is certainly in contrast to the situation in most fishes, where sperm live only a few minutes (Hoar, 1957) to a few hours (Miller, 1952) on exposure to the external environment. Eggert (1931) claims a doubling of the length of time that sperm remain active due to the secretions of accessory reproductive organs in some gobies, but the time involved is still in terms of minutes. A very specialized portion of the sperm duct is found in the cottids that were studied. It might well be said to represent an accessory reproductive organ. There is the possibility that the "sheath" seen on the sperm under the electron microscope is some of the material secreted by the epithelium of this region. Adhering to the sperm, this material may be responsible for the amazing duration of viability. Whether the secretion serves a nutritional, protective or some other function is unknown. More work on this interesting aspect will probably contribute a solution to the problem.

Summary

A study of the sperm of two very closely related species of cottid fishes was made utilizing the electron microscope. It represents what is hoped will be the beginning of a study to determine the relationship of sperm morphology seen in electron micrographic "silhouettes" to the systematics of the group. The size ranges of the sperm and their parts were measured and compared. The spermatozoa of *Oligocottus snyderi* are considerably smaller but relatively thicker than those of *O. rubellio*. It is suggested that the extremely long period of viability found for the sperm of *O. snyderi* when subjected to the external environment may be related to the secretion of accessory reproductive glands forming a "sheath" about the sperm, the specific nature of which is unknown.

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INTER-AMERICAN TROPICAL TUNA COMMISSION, LA JOLLA, CALIFORNIA AND SCHOOL OF MEDICINE, STANFORD UNIVERSITY, STANFORD, CALIFORNIA

The Eastern, Tropical Pacific Fishes of the Genus *Blenniolus,* including a New Island Endemic[1]

RICHARD J. KREJSA[2]

THE present study grew out of an attempt to identify the eastern Pacific blenniid material in the Fish Collection of the Department of Zoology at the University of California, Los Angeles (UCLA). The collection contained a number of specimens of *Blenniolus* from the Revillagigedo Islands which appeared to differ in some respects from the only described species, *B. brevipinnis* (Günther). A preliminary comparison revealed that while the mainland and island populations agreed in most meristic characters, they differed markedly in color pattern and size. It soon became obvious that the apparent differences could not be fully evaluated without a consideration of the ontogeny of the color pattern. The rich collections at UCLA contained good numbers of larvae and adults of both groups. These allowed the ontogeny of both proportions and color pattern to be determined with confidence. This study indicated that the latter differ throughout life and that the mainland and Revillagigedo populations are specifically distinct (Figs. 1–4). In addition, it has been apparent for some time that several enigmatic blenniid species and genera were based on growth stages of *B. brevipinnis* and therefore must be synonymized with that species. In order to document these alterations in blenniid taxonomy, *B. brevipinnis* is herein redescribed on the basis of a large number of specimens, representing the various stages of its life history.

Acknowledgments.—I wish to thank the following persons for making available specimens in their care: Dr. George S. Myers and Miss Margaret H. Storey of the Natural History Museum of Stanford University (SU); Dr. W. I. Follett and Mrs. Lillian J. Dempster of the California Academy of Sciences (CAS); Dr. Casimir C. Lindsey and Mr. J. Donald McPhail of the University of British Columbia (BC); and Mr. Wayne J. Baldwin of UCLA. Thanks are due to Dr. Ethelwynn Trewavas and Mr. G. Palmer of the British Museum (Natural History) (BMNH) for examining and providing me with information on the type specimens of *B. brevipinnis.* I am indebted to Dr. H. R. MacMillan for providing me with the opportunity to obtain life color notes on the new form while aboard the 1960 cruise of the "Marijean" to the Revillagigedo Islands. Mr. James E. Rupert, of Scripps Institution of Oceanography, took the photographs that appear in the text. To Dr. Boyd W. Walker, of UCLA, and Dr. Carl L. Hubbs, of Scripps Institution of Oceanography (SIO), my most sincere thanks for their valuable suggestions and critical reviews of the final manuscript. Finally, it is a pleasure to acknowledge the invaluable assistance of Dr. Richard H. Rosenblatt, of Scripps Institution of Oceanography, for his constructive criticism and frequent assistance and direction throughout the preparation of this manuscript.

TERMINOLOGY AND METHODS

The term prejuvenile, used herein, is adopted as proposed by Hubbs (1958), "to cover a diversity of more or less strikingly—often bizarrely—modified pelagic life history stages, of various marine fishes, that are not appropriately termed either postlarval or juvenile."

In addition to the abbreviations listed in the acknowledgments, the following are used

[1] Contributions from the Scripps Institution of Oceanography, New Series.

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in the synonymy: ANSP, Academy of Natural Sciences of Philadelphia; CNHM, Chicago Natural History Museum; and USNM, United States National Museum.

With the exception of the following, all counts and measurements were taken in accordance with the methods of Hubbs and Lagler (1958):

The last ray of dorsal and anal fins.—Radiographs reveal that in *Blenniolus, Hypsoblennius,* and *Homesthes,* the last ray has its own basal element and is therefore counted independently of the penultimate ray.

Caudal rays.—Radiographs reveal that in *Blenniolus, Hypsoblennius,* and *Homesthes,* two dorsal unbranched rays and two ventral unbranched rays, in addition to the branched caudal rays, articulate with the hypural. Therefore, the number of principal rays is defined for these genera as the number of branched rays plus four (for this is the obvious count). In Table 2 the principal rays are given as dorsal plus (+) ventral.

Body depth.—Taken from a point immediately behind the base of the first dorsal spine to the angle between the outer pelvic base and the body wall.

Length of pelvic fin.—Taken from the inner pelvic base, i.e., between the fourth rays, to the tip of the longest ray.

Abdominal length.—Taken from the inner pelvic base to the anterior rim of the anus.

Measurements of the least bony interorbital width were made by drying the area with air and then were read to within 0.025 mm. accuracy with an ocular micrometer. All other measurements were measured to within 0.1 mm. with break-arm dividers with one flat point and one needle point.

The measurements of the sexes have been combined, since, except in respect to the length of the orbital cirri, I have found no significant morphometric differences between males and females.

The Genera of Blenniinae in the Eastern Tropical Pacific

Blenniolus is one of three genera of the subfamily Blenniinae into which the species of the eastern tropical Pacific appear to be most satisfactorily classified, in accordance with the characters outlined in the following key. A further discussion of these genera is included in the account of *Blenniolus brevipinnis.*

Other blenniine genera, much in need of revision, occur in western South America south of the tropics. The three species of the Californian fauna are referred to *Hypsoblennius.*

Key to the Genera of Blenniinae in the Eastern Tropical Pacific

1a.—Pelvic rays I, 3; vertebrae 33–37. Margin of dorsal fin entire or slightly notched; dorsal rays XII (XI–XIII), 17 (15–19); anal rays II, 18 (16–20); lateral line ranging from incomplete to complete . . . . . *Hypsoblennius*

1b.—Pelvic rays I, 4; vertebrae 29–32.

2a. Dorsal fin with a shallow notch between the spinous and soft portions; dorsal rays XII (XI–XIII), 16 (15–17); anal rays II, 17 (15–19); lateral line complete, or nearly so, extending at least to middle of soft dorsal fin; vertebrae 32 (counted for *H. caulopus* only) . . . . *Homesthes*[3]

2b. Dorsal fin deeply notched; dorsal rays XII (XI–XIII), 12 (11–13); anal rays II, 14 (12–15); lateral line incomplete, never extending beyond first dorsal soft-ray; vertebrae 29–31 . . . . . *Blenniolus*

Genus *Blenniolus* Jordan and Evermann

Figs. 5–6

Blenniolus.—Jordan and Evermann, 1898: 2386 (diagnosis, as subgenus; type *Blennius brevipinnis* Günther, 1861).

The body is short, stocky and moderately compressed. The head is blunt. The snout is rounded in prejuveniles, but steep to nearly vertical in juveniles and adults. In prejuveniles a broad supraocular bony plate, which decreases abruptly in width at metamorphosis (Fig. 10), interrupts the lateral outline of the head just before the eye (Fig. 8). The mouth is small and horizontal: the maxillary ends under the anterior margin of the pupil in prejuveniles, but extends as far as the rear margin of the orbit in adults. The fixed, subequal, incisiform teeth are in a single series, with no canines. The united gill membranes form a slight fold across the isthmus. The gill openings are restricted to the sides and are slightly larger than the base of the pectoral. Prejuveniles have one or no strong preopercular spine; juveniles and adults have none and the rear margin of the preopercle is smooth and broadly rounded. There are 12 or, occasionally, 13 preoperculomandibular pores or sets of pores, usually with 1 to 3, but never more than 5, paired sets. The 2 to 5 slender supraorbital cirri arise from a com-

[3] Includes *Homesthes paylensis* (Steindachner, 1876), n. comb.

Fig. 1. *Blenniolus proteus*, holotype, USNM 179306, a 26.4 mm. male.
Fig. 2. *Blenniolus proteus*, paratype, SU 53152, a 19.8 mm. prejuvenile.
Fig. 3. *Blenniolus brevipinnis*, SIO 59-225, a 31.0 mm. female.
Fig. 4. *Blenniolus brevipinnis*, UCLA 56-356, a 16.0 mm. prejuvenile.

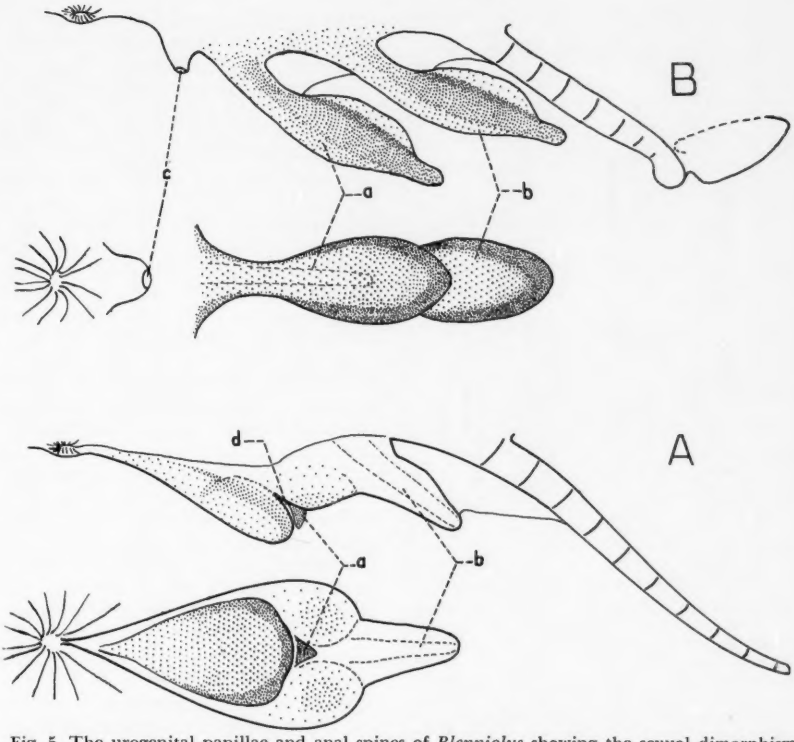

Fig. 5. The urogenital papillae and anal spines of *Blenniolus* showing the sexual dimorphism exhibited by (A) females and (B) males: a, first anal spine; b, second anal spine; c, urogenital pore of male; d, urogenital opening of female.

mon base; the outermost cirrus is thrice as long as the inner cirri and is longer in mature males than in females. The anterior nostril is a low tube surmounted by a narial flap about as long as the space between the anterior and posterior nostrils.

The dorsal fin is short and continuous; its origin is slightly in advance of the upper edge of the gill slit; there is a distinct, relatively deep notch between the low spinous portion and the higher soft portion; dorsal rays XII (XI–XIII), 12 (11–13).

The anal fin is narrow; the soft-rays increase in length posteriorly, and the eleventh or twelfth ray is longest. The interradial membranes are shallowly incised, leaving the distal third of each ray free. A low membranous keel extends along each side of the basal two-thirds of each soft-ray. The anal spines are short. In males, the sub-equal spines are half as long as the first soft-ray,

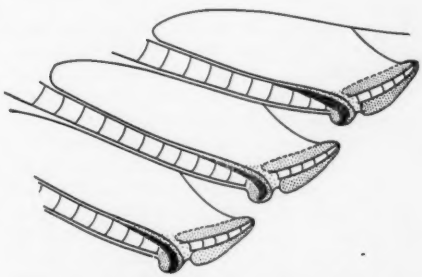

Fig. 6. Anal soft-rays of *Blenniolus* showing the fleshy bulbs and the posteriorly directed tabs which occur only in mature males.

and a broad fleshy keel develops at the tip and on either side of the distal third of each spine. In mature males this keel forms a smooth, non-convolute, spatulate pad (Fig. 5). In females the first spine is about one-fourth and the second spine one-third as

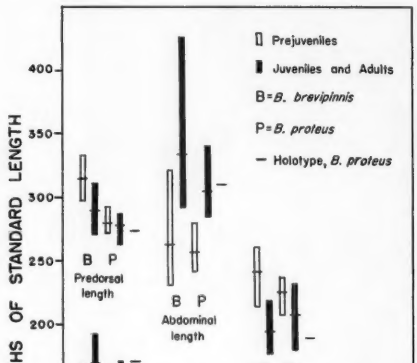

Fig. 7. Ranges and means of allometric proportional measurements comparing prejuveniles with juveniles and adults of both species of *Blenniolus*. The solid and hollow bars represent the ranges and the horizontal dashes represent the means. The number of specimens (N) in each group is as follows: *B. brevipinnis* prejuveniles (26), juveniles and adults (25); *B. proteus* prejuveniles (12), juveniles and adults (15). For the interorbital width of *B. brevipinnis* only, N = 21 for prejuveniles, and N = 13 for juveniles and adults.

long as the first soft-ray. In prejuveniles, and juvenile and adult males, both anal spines are visible. In juvenile and adult females, however, the first spine is almost completely enfolded by the urogenital papilla and, except for the tip, cannot be seen without dissection (Fig. 5). In mature males the tips of the anal rays are swollen. On the rays, distal to the insertion of the interradial membrane, low lateral keels terminate in a fleshy bulb. Distal to the bulb, the investing membrane of the ray is thickened to form a posteriorly directed tab (Fig. 6).

In prejuveniles the anus is followed posteriorly by another small pore, around which the urogenital papilla will form. In males, this papilla is developed as a blunt tube, but in females the tube expands laterally and posteriorly to form a hood over the tip of the first anal spine. Swollen ridges develop around the base of the first anal spine and enfold all but the tip (Fig. 5).

The narrowly rounded pectoral fin has 14 (13–15) rays; the tenth (rarely ninth) ray is the longest. As in prejuveniles of species in related genera the lower half of the pectoral is boldly covered with black or brown chromatophores. There is a Y-shaped black chromatophore immediately behind the base of each anal spine and soft-ray, and, in larger prejuveniles, another at the junction of the anal membrane and the caudal peduncle. As in related genera, the bold pectoral pigmentation and the specks at the base of the anal rays are lost at metamorphosis. The pelvic fins are inserted slightly in advance of the base of the pectorals; rays I, 4; the anal fin is low; rays II, 14 (12–15). The caudal fin is free from the dorsal and anal; its outline is truncate to slightly emarginate in prejuveniles and convex in adults; the procurrent caudal rays number 7 to 11 dorsally, and 6 to 9 ventrally. The incomplete lateral line never extends beyond the first dorsal soft-ray. The vertebrae number 29 to 31. In prejuveniles, never more than 6 saddle-like bars develop across the back. Scales are lacking and the skin is smooth.

The two known species of *Blenniolus* are contrasted in Table 1.

Blenniolus proteus, *sp. nov.*

Figs. 1, 3, 7, 9–10

Scartella atrimana (misidentification).—Clark, 1936:393 (Isla Socorro material only).

The comparison of the species of the genus (Table 1) furnishes a diagnosis of *B. proteus*. Counts and proportional measurements of

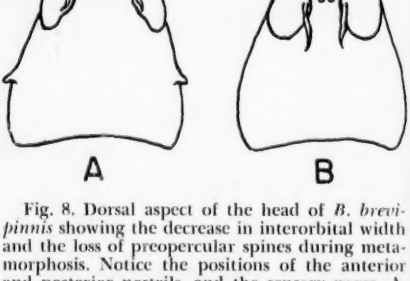

Fig. 8. Dorsal aspect of the head of *B. brevipinnis* showing the decrease in interorbital width and the loss of preopercular spines during metamorphosis. Notice the positions of the anterior and posterior nostrils, and the sensory pores. A, 15.3 mm. prejuvenile; B, 16.0 mm. juvenile. Except for the loss of preopercular spines (which are not present in *B. proteus*), the changes illustrated are typical of both species.

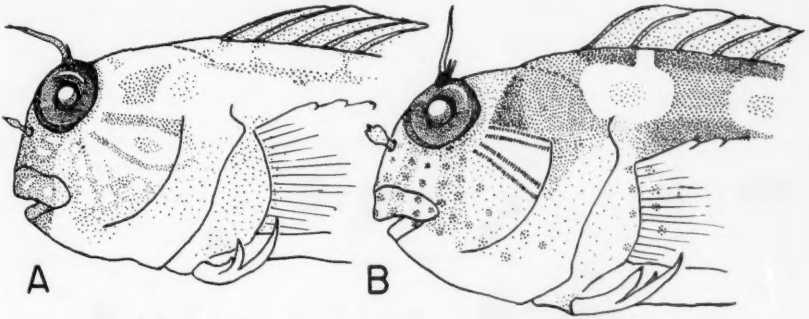

Fig. 9. Lateral aspect of adults of *B. proteus* (A) and *B. brevipinnis* (B).

the two species are presented in Table 2 and in Fig. 7.

Comparisons

Numerous characters distinguish *B. proteus* from its cognate, *B. brevipinnis* (Tables 1 and 2). The physiognomy of both species differs at all ages (Figs. 1–4, 9). *B. proteus* also has certain features in common with species of the allied genera *Homesthes* and *Hypsoblennius*. In addition to the characters given in the generic key, *B. proteus* differs from *Homesthes caulopus* Gilbert in that *caulopus* has a nearly complete lateral line, numerous multibranched lateral-line and head pores, and a stalked supraorbital tentacle with many branches. *H. caulopus* is more robust than *B. proteus* and is a much larger species, attaining a length of four inches. In the adult stage, *B. proteus* may be immediately separated from the various species of adult *Hypsoblennius* by its smaller size, and by its more robust appearance, which is correlated with the lesser number of vertebrae, 30 to 31, as contrasted with 33 to 37. Furthermore, no adult *Hypsoblennius* has a similar color pattern, and none [except *H. gentilis* (Girard)] has a single large orbital tentacle (in that species, however, the trailing edge of the tentacle is partly fimbriate). Prejuveniles of *Hypsoblennius*, while possessing a color pattern very similar to that of *B. proteus*, are at once distinguishable by having three (rarely two) preopercular spines as compared to none in *B. proteus*. By careful examination it is possible even in prejuveniles to detect the generic distinction in number of pelvic rays (I, 4 in *Blenniolus*, I, 3 in *Hypsoblennius*).

Like some other insular endemics among marine fishes (Carl L. Hubbs, personal communication), *B. proteus* seems to have become reduced in certain characters (though an hypothesis of primary simplicity is not readily excluded). It is definitely a smaller fish, with weaker texture and simpler coloration, with fewer dorsal saddles. It seldom develops even a trace of the preopercular spine. It has fewer and simpler supraorbital tentacles, and a simpler narial flap. Fewer of the preoperculomandibular pores are paired.

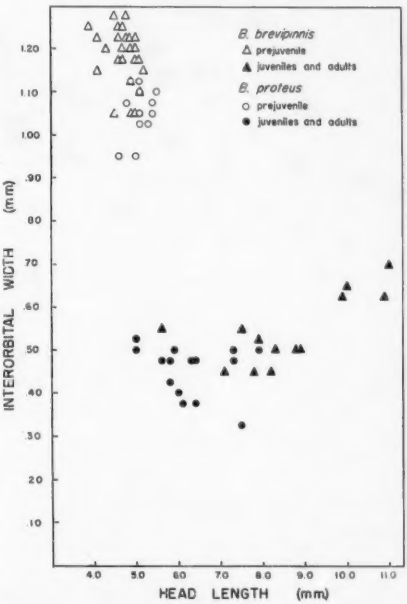

Fig. 10. Plot of absolute measurements showing the sharp decrease in interorbital width during metamorphosis in *Blenniolus*.

TABLE 1. SOME DISTINGUISHING CHARACTERS OF THE SPECIES OF *Blenniolus*

Character	*B. proteus*	*B. brevipinnis*
Range	Islas Revillagigedo	Golfo de California to Perú
Greatest standard length	Under 30 mm.	To 40 mm.
Supraorbital tentacles	Two, evenly peppered with melanophores	Three to five, clear except for basal black ring
Procurrent caudal rays	8–11 above, 7–9 below	7–9 above, 6–8 below
Vertebrae	30–31	29–30
Preopercular spines in prejuveniles	None, or one vestigial[1]	One, short, flat, blunt spine[2] at the angle, rarely with vestigial second[3]
Dorsal saddles in prejuveniles (full complement)	Five	Six
Peritoneum in adults	Clear	Black or brown
Black dots on body behind pectoral fin in adults	Three to 10	None
Body color of adult (in alcohol)	Very light; lateral and dorsolateral stripes narrow and faint, almost vestigial. No chain-like interspaces on body	Darker; lateral and dorsolateral stripes broad and dark. Chain-like interspaces on body between stripes
Number of paired preoperculomandibular pores	1 or rarely 2	2 or 3, rarely 4 or 5
Anterior narial flap	A slender filament never with projections	Lanceolate, occasionally with blunt, terminal projections
Lateral line terminates	Above the midline between tenth and eleventh dorsal spines	On the midline under or just in front of first dorsal soft-ray
In juveniles and adults the maxillary ends between verticals from	Midpoint of eye and hind margin of pupil	Hind margin of pupil and rear margin of orbit
Lower margin of eye in prejuveniles	Opposite seventh to ninth pectoral ray	Opposite fifth or sixth pectoral ray
Lower margin of eye in juveniles and adults	Opposite or above third pectoral ray	Opposite or above first pectoral ray

[1] In one specimen (17.1 mm., UCLA 55-136), a vestigial spine is present on each side at the angle.
[2] In the smallest specimen of *B. brevipinnis* (11.5 mm., UCLA 58-352), this spine is long and sharp and is contained almost three times in the length of the head. In larger prejuveniles, the spine decreases in length and becomes flatter and blunter.
[3] Rarely there is a second vestigial spine on the ventral margin of the preopercle, just anterior to the spine at the angle.

Only in the greater number of procurrent caudal rays and vertebrae does *B. proteus* tend to exceed. In coloration, in the shorter and more rounded head, and in the more slender body, *B. proteus* appears to diverge less in ontogeny than does *B. brevipinnis*.

COLOR IN ALCOHOL

Prejuveniles.—The chromatophores in most specimens are dispersed and brown; occasionally they are contracted, and then appear as black dots. The ground color of the prejuvenile is light cream-yellow. When viewed from above, a deep-lying layer of giant brown chromatophores forms a crescentic saddle over the midbrain. The occiput is superficially covered by a less dense layer of brown chromatophores that extend ventrally to the upper edge of the opercle. A few brown chromatophores are scattered on the lower half of the cheek, on the opercle, along the suborbital and preorbital, and on the

TABLE 2. MERISTIC COUNTS AND PROPORTIONAL MEASUREMENTS OF THE TWO SPECIES OF *Blenniolus*

	B. brevipinnis	*B. proteus*	
	Mean (range)	Mean (Range)	Holotype
Counts:			
Dorsal spines	12.0 (11–13)	12.0 (11–12)	12
Dorsal soft-rays	11.9 (11–13)	12.2 (12–13)	12
Anal spines	2.0 ...	2.0 ...	2
Anal soft-rays	13.9 (12–14)	14.1 (14–15)	14
Pectoral rays	14.0 (13–15)	14.0 (13–15)	13
Pelvic spines	1.0 ...	...	1
Pelvic soft-rays	4.0 ...	4.0 ...	4
Caudal rays:			
Principal	7 + 6 ...	7 + 6 ...	7 + 6
Procurrent (dorsal)	7.7 (7–9)	9.0 (8–11)	9
Procurrent (ventral)	7.1 (6–8)	8.3 (7–9)	8
Vertebrae	29.8 (29–30)	30.6 (30–31)	31
Measurements:			
Standard length, mm	11.5–39.6	17.0–28.5	26.4
Head length	307 (282–326)	287 (265–306)	284
Body depth	267 (228–298)	233 (216–260)	231
Snout length	102 (81–120)	91 (80–102)	91
Upper jaw length	101 (83–126)	92 (74–117)	91
Longest pectoral ray	263 (221–296)	264 (241–286)	254
Caudal peduncle depth	100 (87–120)	89 (78–108)	79
Second dorsal spine	132 (95–165)	129 (112–147)	132
Penultimate dorsal spine	61 (33–80)	60 (38–72)	72
Last dorsal spine	39 (28–53)	30 (21–43)	23

Measurements are expressed in thousandths of the standard length. The numbers of specimens in the samples are as follows, for *B. brevipinnis* and *B. proteus*, respectively, are 77 and 29 for dorsal, anal, pectoral, and pelvicray counts; 35 and 29 for caudal-ray counts; 9 each for vertebrae, and 51 and 27 for all measurements.

snout. The interorbital space and the lips are lightly sprinkled with punctate black and brown chromatophores. The chin and throat are immaculate.

Five bars of brown chromatophores develop across the back (Fig. 2). In the largest prejuvenile at hand (19.8 mm., UCLA 55-128), and in another specimen intermediate in size (18.1 mm., UCLA 55-152), all five bars are present. The first four bars extend ventrally to the midline, but the fifth (peduncular) bar is dorsal only and does not extend onto the sides. In the smallest specimen at hand (17.0 mm., UCLA 53-45), only four dorsal bars are present and these do not extend ventrally. No smaller specimens are available for comparison but it may be assumed that in this species, as in *B. brevipinnis*, the bars appear anteriorly at first and successively develop posteriad with increase in age.

Juveniles and adults.—The following condition, although transient, seems more significant than the loss of the bolder pectoral pigmentation at metamorphosis. The areas formerly covered by vertical bars in prejuveniles gradually become free of brown chromatophores and the deep integument of each area takes on the appearance of a faint, but distinguishable, pale orange bar. This may be an artifact of preservation since the bars closely approximate the limits set by the brown chromatophores in the prejuvenile. The cream-yellow spaces between the orange bars become superficially covered by punctate black chromatophores. As growth proceeds, these chromatophores outline flat dorsolateral hexagons, each of which is connected to the dorsal base by two short vertical lines and to the midline by two ventrally divergent lines. In addition, each interspace has a thin horizontal line of black on the midline. In the adult the upper base of each hexagon traverses the orange bars both anteriorly and posteriorly to form a thin, ragged, dorsolateral stripe, which extends

from the base of the last dorsal ray to a point on the occiput approximately one pupil diameter ventral and anterior to the dorsal insertion. Likewise, the chromatophores on the midline traverse the orange bars to form a broken horizontal line that extends from the caudal peduncle to the tip of the opercular flap. One apparently transitional specimen (17.8 mm., UCLA 55-152), lacks the bold pectoral pigmentation, retains vestiges of the vertical brown bars of the prejuvenile, and possesses the beginnings of the juvenile pattern as described above.

The pectoral base is peppered with punctate black chromatophores, as are the lowermost six pectoral rays. Three to 10 giant black contracted chromatophores, not present in the prejuvenile, appear in the deep integument of the axilla.

The network of giant brown chromatophores that saddled the occiput of the prejuvenile appears as punctate black chromatophores in the juvenile. Two characteristic bands of black radiate from the orbit. The upper band is horizontal or sub-horizontal and extends from the mid-orbit, across the cheek, and onto the opercle. The second band is curved and extends from the orbit to the preopercular margin at an angle of about 25° below the horizontal. A third diffuse band occasionally extends across the cheek at an angle of about 60° below the horizontal. In juveniles the opercle and the chin, and in mature specimens the throat as well, are peppered with black. The rim of the orbit, the interorbital area, the snout, the lips, and the suborbitals and preorbitals are similarly peppered, but several, scattered, unpigmented blotches give the face a piebald appearance. The anterior nostril is lightly dusted, and the orbital tentacle is heavily dusted with black (Fig. 9A).

The entire spinous dorsal fin is dusted with black. The distal third to half of the soft dorsal is likewise dusted with black, but the basal portion is clear. The basal third of the anal fin is clear, the medial third is dusted with black, and the distal third is white. The caudal base and the margin of the caudal fin are dusted with black and each caudal ray is edged with black, but the remainder of the fin is clear.

Color in Life

The following notes were taken from three adult males (BC 60-255) three hours after capture and preservation at Caleta Grayson. The basic ground color of the head is olive-green. The wide postorbital bar that radiates across the cheek is rusty-orange but a scattering of irridescent blue-white dots gives it a pinkish cast when viewed in strong sunlight. The bar is bordered above and below by a narrow, irridescent blue-white ray. The half-crescent mark behind the eye and above the cheek is blue-black. The chin, lips and throat are light, olive-green. The spots on the chin, snout and suborbital, which, in preserved specimens, give the face a piebald appearance, are actually arranged in distinctive bands radiating from the orbit. These spots and those on the cheek and opercle are olive-orange and have a golden cast when viewed in strong sunlight. The supraorbital tentacles and the anterior nostrils are orange and peppered with brown.

The iris is rusty-orange except for a ring of irridescent blue-white which borders the pupil. A blue-white slash crosses the outer base of the pectoral fin. The interradial membranes of the pectoral fin are clear. The radial membranes are peppered with black but more boldly on the lower six rays. The dorsal fin is light olive-green and is dusted with black more densely on the spinous than on the soft dorsal. The anal fin is light olive, blending into dark olive-brown at the middle and then into white at the tips. The base of the caudal fin is light olive, blending into pale yellow at the distal third and the distal margin is clear.

A series of five, dark, olive-brown bars cross the back and extend saddle-like down to the midline of the body. The first saddle extends under the first four dorsal spines; the second is located under the sixth to ninth spines; the third extends from under the ultimate dorsal spine to the first four dorsal soft-rays; the fourth extends from the seventh to the penultimate ray; and the fifth is located on the caudal peduncle. In two of the specimens at hand the first and the second saddles are contiguous and, when viewed dorsally, appear as a tongue-like projection from the first to the ninth spines. An irregular, flesh-colored, dorsolateral stripe bisects the lateral wings of the first three, and occasionally the fourth, saddles. Irregular, dark olive-brown blotches fill part of the flesh-colored interspaces between the saddles. In addition, an irregular series of irridescent blue-white spots is found in the interspaces and along the midline of the body. The ventral half of the body is flesh-colored and peppered with black.

Distribution

Range.—All known specimens were taken about the Revillagigedo Islands, to which *B. proteus* is apparently confined. According to Dr. Richard H. Rosenblatt (personal communication), this is the only blenniid known to be endemic to any of the islands of the eastern tropical Pacific. *B. brevipinnis,* on the other hand, ranges along the Pacific Coast of the Americas from México to Perú and, in addition, to the Galapagos and Cocos Islands. *B. proteus* has never been taken on the mainland, although the distance separating Clarion and Socorro Islands is almost as great as that which separates Socorro from the mainland. Furthermore, Clarion and Socorro are separated by deep water. It is probable, therefore, that the factors which restrict *B. proteus* to its insular habitat are ecological and that its insularity is not a mere product of distance.

Material examined.—A total of 32 specimens from 14 collections. Place names in the Revillagigedo Archipelago conform to those suggested by Richards and Brattstrom (1959).

Holotype.—USNM 179306 (formerly UCLA 55-152), a male 26.4 mm. in standard length, from the north edge of Caleta Binner on Isla Socorro, of the Revillagigedo Archipelago, México: depth of water, to 5 feet; bottom coral heads and larva: predominant vegetation, species of *Ralfsia, Dictyosphaera,* and *Neomeris*; water temperature, 76° F.; collected May 1, 1955, by Richard H. Rosenblatt and Bayard H. Brattstrom.

The 24 paratypes include 9 (USNM 179305), 17.8–22.6 mm. long, collected with the holotype and the following additional specimens from Caleta Binner on Isla Socorro: BMNH 1959. 8. 10. 1 (formerly UCLA 53-350), 1 (24.4 mm.); and CAS 21219 (formerly UCLA 55-126), 1 (19.0), and UCLA 53-49, 1 (21.0), from rocky area east of landing place; still others from Isla Socorro are: SU 53151 (formerly UCLA 55-156), from front of point marking southwest end of next cove north of Caleta Binner, 3 (20.6–26.5); SIO 58-142, Bahia Braithwaite, 1 (26.5); BC 57-152, Bahia Braithwaite, 1 (17.9); and BC 57-158, Caleta Grayson, 1 (28.5).

Six paratypes came from other islands in the Revillagigedo group: CNHM 62774 (formerly UCLA 53-45), from the southeast side of San Benedicto, 2 (17.0–17.6); and SU 53152 (formerly UCLA 55-128), ¼ mile west of Roca Partida, 4 (18.3–19.8).

Four additional specimens, not designated as paratypes, came from Isla Clarion, of the Revillagigedo group: UCLA 55-136, from anchorage at southeast end of island, 2 (17.1–17.5); UCLA 59-153, no other data, 1 (17.0).

Three specimens, recently collected at Isla Socorro, were not designated as paratypes: BC 60-255, Caleta Grayson, about 50 feet west of the water hole, 3 (25.7–26.3).

Etymology.—In Greek mythology Proteus was a sea-god, Neptune's herdsman, whose distinguishing characteristic was the faculty of assuming different shapes. The name is applied to *B. proteus* in allusion to the changes that occur during the metamorphosis of this and other blenniines.

Blenniolus brevipinnis (Günther)
Figs. 2, 4, 7–10.

Blennius brevipinnis.—Günther, 1861a:373 (original description; "West Coast of Central America"); 1861b:226 (description; "Sandwich Islands" and "West Coast of Central America"); 1869:389 (Central America). Steindachner, 1876:84, pl. 8 (description; Navidad, near Mazatlan). Günther, 1877:194 (description, "West Coast of Isthmus of Panama and Sandwich Islands"). Boulenger, 1899:8 (St. Helena Bay, Ecuador).

Isesthes brevipinnis.—Jordan and Gilbert, 1883:108 (Mazatlán).

Hypsoblennius brevipinnis.—Jordan and Evermann, 1898:2390 (description; synonymy; Mazatlán to Panamá; type of subgenus *Blenniolus*). Gilbert and Starks, 1904:193 (Panamá Bay). Meek and Hildebrand, 1928:946 (description; Chame Point, Panamá).

Scartella brevipinnis.—Hubbs, 1927:365 (generic reference and synonymy). Jordan, Evermann, and Clark, 1930: 461 (synonymy; Mazatlán to Panamá).

Homesthes brevipinnis.—Norman, 1943: 803 (generic reference).

Blenniolus brevipinnis.—Fowler, 1944: 229 and 298 (description and synonymy; north of Galápagos, at 4° 53′ N., 81° 31′ W.; Playa Muerto, Panamá); Ricker, 1959:12 (Las Tres Marías, México).

Syntypes.—BMNH 1855. 9. 19. 751 and 1861.8. 13. 17.

Hypsoblennius striatus (not of Steindachner). —Fowler, 1919:128 (Panamá City, Panamá).

Spinoblennius spiniger.—Herre, 1935:435 (orignial description, Eden Island, Galapagos Islands); 1936:399, fig. 39 (description: same material).

Holotype.—CNHM 17395.

Scartella atrimana.—Clark, 1936:393–4 (original description; Albemarle (Isabela) Island, Galápagos Islands, and one paratype, from Banderas Bay, México).

Holotype.—CAS 3988. Paratypes.—CAS 5498 and CAS 21220.

Spinoblennius actesoma.—Fowler, 1944:232, 251, and 401, fig. 248 (original description; Playa Muerto, Panamá; Bahía Santelmo, Isla del Rey, Islas Perlas, Panamá: Isla María Madre, Islas Tres Marías, (México).

Types.—ANSP 70086 and 70087.

The characters of this species are presented in the account of the genus, in the figures, and in Tables 1 and 2.

Nomenclatural History

As outlined in the preceding synonymy, the species *brevipinnis* was first referred to the then very inclusive genus *Blennius*, which has now been much divided, as by Norman (1943). It was [illegible] referred to the rather speciose New World genus *Hypsoblennius* and its synonym *Isesthes*. Hubbs, misinterpreting the character of the gill membranes, referred the species in 1927 to the Western Atlantic genus *Scartella*. Norman, in 1953, referred it to *Homesthes*, with which, as indicated in the key above, it shares several characters, though a combination of other characters seems to warrant generic separation, especially now that two species are referable to each genus. *Blenniolus* was first recognized as a genus by Fowler in 1944, but the same author, as well as Herre, 1935, and Clark, 1936, described the prejuveniles of *B. brevipinnis* under two other generic and three specific names. This species has apparently only once been misidentified as a species (*Hypsoblennius striatus*) of another genus.

Color in Alcohol

Prejuveniles.—The ground color is light cream-yellow. When viewed from above, a deep-lying layer of giant brown chromatophores forms a crescentic saddle over the midbrain. The occiput is superficially covered by a less dense layer of brown chromatophores that extend laterally over the preopercle and opercle and under the eye. A small patch on the preopercle, just behind the lower half of the eye, is free of chromatophores. A narrow diffuse band of brown chromatophores radiates from the anterior corner of the orbit across the maxillary and onto the lower lip just before the angle of the gape. There is a scattering of chromatophores on the upper lip. The snout and chin are immaculate, except for a narrow, black-brown chromatophore located in the deep integument of the chin at the symphysis.

Six saddle-like bars of brown chromatophores develop across the back (Fig. 4). These appear anteriorly at first and successively posteriad with increase in age. In the smallest specimens at hand (11.5 mm., SIO 58-352; 11.7 mm., UCLA 54-293), only the faint beginnings of the first bar are present. In a slightly larger specimen (13.5 mm., UCLA 54-293), there are one and one-half bars. At 14 mm., two bars are visible; only in the largest prejuveniles (16.1 mm., UCLA 56-358), are all six bars present. With increase in size, the saddles become angular, roughly hourglass-shaped bars, which extend ventrally to the midline. The resultant interspace between the bars is hexagonal and light cream-yellow.

Juveniles and adults.—In contrast to the condition in *B. proteus*, the pigment pattern of the prejuvenile is intensified in the juvenile, and fully expressed in the adult. The entire body is overlaid with punctate black and brown chromatophores. The small light patch on the upper cheek of the prejuvenile is developed in the adult as a broad, pearly-white band, which extends from the orbit to the preopercular margin at an angle of approximately 25 to 30° below the horizontal. The upper and lower margin of this band are each bordered by a double set of thin brown lines. A characteristic half-crescent of black pigment is developed just behind the eye above the cheek (Fig. 9B).

The occipital saddle of the prejuvenile is expressed to varying degrees in the adult. In some it appears as a slightly darker, shaded area; in others, as a very dark saddle overlaid by a honeycomb of thin white lines. The preorbital band is most pronounced in adults. The opercle, the lower half of the cheek, the suborbital, preorbital, snout and upper lip are peppered with brown spots, each approximately as large as the posterior nostril. In some individuals there are similar spots on the pectoral base and on the upper sides above the pectoral. In some specimens

the spots appear to radiate in bands from the orbit, but in others, the spotting is more dense, and a honeycomb pattern may be formed. The base of the orbital tentacle is ringed with black, but the individual cirri are immaculate, as is the anterior nostril. The dusky chin and throat region is crossed by a broad, lightly pigmented X, which is obvious in juveniles but rather diffuse in adults.

In adults the hourglass-shaped bars are contiguous, or nearly so, so that a dark-brown dorsolateral stripe is formed along the base of the dorsal fin and a dark lateral stripe just above the midline. The hexagonal, cream-yellow interspaces of the prejuvenile become more oval with age. Since in adults the ends of these interspaces are nearly contiguous, a light chain-like stripe is formed between the darker lateral stripes. A spot of brown in the center of each oval interspace accentuates this chain-like appearance. The lower dark lateral stripe usually includes five or six cream-yellow spots in its course but it may be partially or completely interrupted.

The spinous dorsal is clear, but dusted with melanophores, more densely basally than distally. The soft dorsal fin is similar in color, but is lighter. The caudal fin is mostly clear, but lightly peppered with black at the base. The anal fin has a light basal band, a characteristic thin, dark, medial band, and a very light distal band.

Color in Life

The following notes were taken from two live females at Cabo San Lucas (SIO 59-223). The basic ground color of the head is olive-brown. The wide postorbital bar that radiates across the cheek is bright lemon-yellow. This bar is bordered above and below by a narrow, brown-edged, pearly-white ray. The occipital saddle forms a honeycomb of brick-red or orange spots, each bordered by blue-violet. The half-crescent mark behind the eye and above the cheek is blue-black. The chin and lips are lemon-yellow. The spots on the chin are brown, and those on the snout, preorbital, suborbital, cheek, and opercle are brick-red to brown. The supraorbital tentacle is ringed with black at the base and the individual cirri are yellow-white. A powder-blue crescent lies immediately behind the base of the tentacle. The anterior nostril is brick-red.

Six equally spaced dark-orange bars radiate from the margin of the pupil, across the light-orange iris. The lower five or six pectoral rays are olive, the upper rays clear. The dorsal fin is clear olive-brown basally and orange distally. The anal fin is cream-orange at the base, blending into dark brown in the middle and then into white at the tips. The base of the caudal fin is clear and the tips are orange. The lateral stripes on the body are chocolate-brown, with creamy-tan interspaces. The center spots in the interspaces are brick-red to brown. The ventral half of the body is creamy-tan.

Distribution

Range.—From Guaymas and Punta Pescadero, in the Gulf of California, to Cabo Blanco, Perú; and Galápagos and Cocos islands.

The provenance of the type specimens of *Blennius brevipinnis* has long been in doubt. Günther (1861b:226) listed two specimens, as follows: "a. Sandwich Islands. From the Haslar Collection." and "b. West Coast of Central America. Collected by Captain Dow."

I have personally examined the "Sandwich [Hawaiian] Islands" specimen, BMNH 1855. 9. 19. 751. It is 33.7 mm. in standard length and, although slightly faded, agrees well with all the meristic, proportional, and phenotypic characteristics given in Tables 1 and 2. Although the specimen is undoubtedly *Blenniolus brevipinnis,* its Sandwich Islands locality is presumably erroneous, as Jordan and Evermann (1898:2391, 1905:504) and Strasburg (1956:243) have indicated.

In a parallel case, Günther (1864:157), listed a siluroid, *Arius dasycephalus,* from the Sandwich Islands, "From the Haslar Collection." In this case, as in that of *B. brevipinnis,* it has been suggested (Jordan and Evermann, 1905:130, and Meek and Hildebrand, 1923:106) that the Sandwich Islands locality of *Galeichthys dasycephalus* (Günther) is in error.

Even Günther (1869:382) had his doubts about the scientific value of the Haslar Hospital collections: "In the second place I have to mention Dr. Seemann, who as naturalist attached to the expedition of the Herald, brought to England a collection of Central American fishes. These, as I have mentioned above, were originally deposited in the collection of the Haslar Hospital, but no record as regards the origin of the specimens was kept, so that most of them are lost for the purpose of this Memoir."

In a final attempt to establish the validity

of the Sandwich Islands locality of *B. brevipinnis,* I searched through the narrative of the voyage of the "Herald." Indeed, the "Herald" did visit the Sandwich Islands on three different occasions, but only as a stopover point on its way to or from the Arctic (Seemann, 1853). I was unable to find an account of any fish collecting done during this part of the voyage. However, Richardson (1854) does allude to some fish collecting done by Drs. Seemann and Goodbridge in the Galápagos Islands. It is not unlikely that the "Sandwich Islands" specimen of *B. brevipinnis* was taken by these men while the "Herald" was in the Galápagos area.

Mr. G. Palmer, of the British Museum, has kindly re-examined the specimen collected by Captain Dow. It is 40 mm. in standard length and the fin-ray counts are in agreement with the ranges given in Table 2. The specimen likewise fits all the distinguishing characteristics as summarized in Table 1. According to G. Palmer (personal communication), this specimen is listed in the register of the British Museum as being from Panamá. Why Günther first recorded it as being merely from the "West Coast of Central America" is a moot question.

On the basis of the foregoing information, the Panamanian specimen, BMNH 1861. 8. 13. 17, is selected as the lectotype of *Blenniolus brevipinnis.*

Material examined.—A total of 217 specimens from 43 collections.

México, Cape region, Baja California Sur. —SIO 59-223, Bahía San Lucas, about 100 yards north of sand beach near tip of Cabo San Lucas, 2 (16.2–17.3 mm. in standard length); SIO 59-210, Bahía San Lucas, 300 yards south of cannery pier, 7 (19.7–36.7); SU 18765, Bahía San Lucas, southwest end, 8 (24.5–32.3); SU 18926, Bahía San Lucas, south side, 600 yards from tip of Cabo San Lucas, 12 (20.3–37.9); SIO 59-225, about one-third mile south of Punta Pescadero, just south of fisherman's camp, 30 (15.5–37.5); SU 47791, northeast corner of Bahía de los Muertos, 2 (15.5–15.8).

México, Golfo de California, eastern shore. —UCLA 51-10, Sonora, Punta San Guillermo, 1 (35.5); UCLA 51-29, Sinaloa, south tip of Isla Lobos, Islas Venados group, near Mazatlán, 2 (27.7–30.7); UCLA 51-54, Sinaloa, isthmus (shoreward side) of Isla Venados, 1 (18.7).

Mexico, Islas Tres Marías.—BC 54-76, Isla Magdalena, 2 (14.8–17.0); BC 57-163, Isla Magdalena, 1 (16.1); BC 57-171, Isla Magdalena, 3 (15.6–16.8); UCLA 56-358, Isla Cleopha, southeast side, 20 (14.2–16.1).

México, Nayarit.—UCLA 58-5, south edge of small point inside larger point at Chacala, 3 (16.0–24.0); UCLA 58-11, three-fourths mile south of point forming the south end of Ensenada Chacala, 1 (19.7); CAS 21220 Banderas Bay, 1 (ca. 16.0), paratype of *Scartella atrimana* Clark.

México, Colima.—UCLA 56-232, west end of Playa de Santiago, about 10 miles northwest of Manzanillo, 14 (13.5–33.3); UCLA 56-230, Playa de Santiago, in vicinity of rocks near Hotel Auita, 7 miles northwest of Manzanillo, 3 (32.2–35.1); UCLA 56-231, Ensenada Carrizal, across bay from Manzanillo, 4 (22.7–27.5).

México, Guerrero.—UCLA 52-112, Puerto del Marques, near Acapulco, 1 (31.2); UCLA 53-190, same locality, 1 (24.9); UCLA 52-119, Acapulco Harbor, 1 (15.2); UCLA 56-17, Playa las Pulgas (El Farallon), 1 (26.5).

Costa Rica.—SIO 58-352, 25 miles west of Cabo Velas, 1 (11.5); UCLA 49-463, 10 miles west of Punta Quepas, 1 (20.4).

Costa Rica, Isla del Coco.—UCLA 56-211, 2 (15.4–15.9).

Panamá.—UCLA 53-31, vicinity of Isla Jicarita, from dugout canoe awash, 1 (17.4); UCLA 51-248, Golfo de Panamá, Isla Montuosa, 4 (14.1–14.6); UCLA 56-304, Golfo de Panamá, taken from floating log, 7 (16.5–33.9); UCLA 55-241, Bahía Panamá, 1 (35.4); SU 6929, Bahía Panamá ?, 1 (17.4).

Colombia.—UCLA 54-304, 25 miles west of Cabo Marzo, 1 (14.4); UCLA 54-332, upper Colombia bank, 1 (14.9).

Ecuador.—SIO 52-20, north-northeast of Cabo San Francisco, 4 (31.4–39.6).

Ecuador, Islas Galápagos.—SU 37576, Isla Seymour, south side, 1 (30.8); UCLA 54-293, Isla Isabela (Albemarle), 5 to 10 miles south of Punta Cristóbal, 2 (11.7–13.5); SIO 51-53, Isla Fernandina (Narborough), Punta Mangle, 1 (34 +, smashed specimen); SU 24423, Eden Island, 4 (14.9–16.0) cotypes of *Spinoblennius spiniger* Herre; CAS 3988, Isla Isabela (Albemarle), off Vilamil, about submerged light, 1 (16.0), holotype of *Scartella atrimana* Clark; CAS 5498, same location as holotype, 56 (ca. 14.0–16.0), paratypes of *S. atrimana* Clark.

Perú, Cabo Blanco.—BC 56-139, 3 (15.5–16.6); BC 56-140, 2 (15.9–16.4); BC 56-158, 1 (13.9).

Remarks on the Life History and Habitat of the Species of

Blenniolus

The prejuveniles of the two species of *Blenniolus,* as well as, so far as known, all species of the closely allied genera *Homesthes* and *Hypsoblennius,* are pelagic in habit. Presumably, as Hubbs (1958:283) suggested for analagous prejuveniles of other marine fishes, their "metamorphosis seems to be triggered by shore conditions, whenever they happen to be encountered." Transformation occurs rapidly and widely, with the result that, within species, prejuveniles overlap juveniles in size (Fig. 10). Breder (1949) found that, when placed in an aquarium, the pelagic larvae of *Acanthurus coeruleus* immediately sought the shelter of shells and began their metamorphosis. He suggested that the young of the species continue to grow and to delay metamorphosis until the currents chance to carry them over a suitable substrate inshore. They then transform immediately into a miniature adult. This theory accounts well for the taxonomic enigma of having larval forms overlapping adults in size. The overlap in *Blenniolus* (Fig. 10) is not as great as in *A. coeruleus,* but Breder's explanation seems applicable.

After metamorphosis, the juvenile settles to the bottom, usually on a substrate of large granitic or volcanic rocks, or coral heads. Apparently, however, *B. brevipinnis* can live in the absence of these habitats, since seven juvenile to adult specimens were taken from a floating log in the Golfo de Panamá (UCLA 56-304). Fowler (1944:295) reported on one 30 mm. adult that was taken when "About 15 miles north of this station [north of Galapagos, 4° 53′ N., 81° 31′ W.] the ship was stopped and the skiff launched. Some small fishes were collected from underneath floating logs." Another specimen (17.4 mm., UCLA 53-31) was taken from a dugout canoe floating in the vicinity of Isla Jicarita, Panamá. Meek and Hildebrand (1928:946), mentioned that their specimens "were taken from old submerged wood, in which they appear to inhabit the crevices, and the burrows of the shipworm."

While skin-diving at Cabo San Lucas and Punta Pescadero, I have observed several individuals of *B. brevipinnis* resting in empty shells of barnacles (*Balanus* sp.), which were attached to the vertical sides of large granitic rocks. Usually, only the head projected from the barnacle shell, but the fish could be readily identified by the bright lemon-yellow cheek bar and the yellow-white supraorbital tentacles, which wave in the surge. Between swells at low water, the retreats were occasionally exposed completely to the air. The fish remained in the shell during these times.

Presumably, like some species of *Hypsoblennius,* and other related genera, the species of *Blenniolus* deposit the eggs within a shell or crevice, where they are guarded by the male.

Ripe females of *B. proteus* have been taken from February through May; collections from other seasons are not available. Ripe females of *B. brevipinnis* have been collected in October (Manzanillo and Costa Rica); in January (Chacala, Isla Lobos, and Punta San Guillermo, México); in February (Panamá); and in March (Cabo San Lucas, Acapulco, and Panamá). Collections are scarce during the midsummer months. The available data suggest that *B. brevipinnis,* at least, may spawn the year around.

Although there is a marked difference in maximum size, there appears to be no significant difference between the species of *Blenniolus* in size at maturity. Both species mature very soon after metamorphosis. Among 30 females of *B. brevipinnis* examined, the smallest sexually mature specimen (UCLA 55-152) was 19.5 mm. long. This specimen retains vestiges of the prejuvenile body pattern and appears to have recently transformed.

Two specimens of *B. proteus* have been collected during an apparent metamorphosis. Both show characters that are primarily juvenile, but they also retain vestiges of the prejuvenile. In one of these (UCLA 59-153), the interorbital width, postorbital length, orbit length, abdominal length, and the length of the first dorsal soft-ray all fall within the range of proportions of the juvenile and adult. However, the color pattern and the lengths of the pelvic fin and the caudal peduncle are typically prejuvenile. This 17.0-mm. specimen is 1.6 mm. shorter than the largest prejuvenile of *B. proteus.* Its sex is indeterminable. The other specimen (UCLA 55-152) is 17.8 mm. in standard length and it is definitely a male. Its orbit length, interorbital width, and abdominal length all fall within the range of proportions of juveniles and adults. However, other characters such as the postorbital length, the length of the caudal peduncle, and the pelvic

length, are intermediate between the ranges of proportions of prejuveniles and juveniles. In addition, as stated in the description, this specimen retains vestiges of the vertical brown bars of the prejuvenile and shows the beginnings of the juvenile color pattern. On the basis of the available data, *B. proteus,* although a definitely smaller species than its congener, *B. brevipinnis,* appears to have a more protracted larval life.

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Parasitic Lampreys of the Genus *Ichthyomyzon* in the Rivers of Illinois

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IN the late 1940's and early 1950's commercial fishermen in Illinois became concerned over the possibility that the sea lamprey, *Petromyzon marinus* Linnaeus, might have invaded the river systems of the state from Lake Michigan. Because of their concern, the Illinois State Natural History Survey and the Illinois State Department of Conservation began a survey of the parasitic lampreys of the larger rivers in 1949, and continued the investigation through 1959.

Of the 454 lampreys taken from the rivers during the study all but one belonged to the freshwater genus *Ichthyomyzon*. The single sea lamprey (now in the Natural History Survey collection) was reported to us as having been taken from the Du Page River, a tributary of the Illinois River in extreme northeastern Illinois; but inasmuch as substantial evidence that the collector actually found the specimen in the Du Page River has not been obtained, we consider the record as doubtful. The occurrence of the sea lamprey in Lake Michigan, however, is well documented. Specimens have been secured off Waukegan, Lake County, Illinois, during this survey.

The objectives of this paper are to analyze variation within our comparatively large series and present data pertaining to the current distribution and abundance of native parasitic lampreys in the larger rivers within or bordering Illinois based upon the material accumulated during our 10-year study.

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HISTORICAL RESUMÉ

The first reference to lampreys in Illinois waters appears to be the original description of *Ichthyomyzon castaneus*. Girard (1858) in one of the Pacific Railroad Survey Reports described the species on the basis of a specimen from "Galena, Minnesota." Suckley (1860) in another report in the same series repeated Girard's diagnosis and cited the locality as "Galena, Illinois?" (There is no Galena, Minnesota. Moreover, the expedition narrative indicates without much doubt that the Galena in question is that of northwestern Illinois.)

Nelson (1876) reported *Ichthyomyzon hirudo* (? equals *castaneus*) from the Ohio River at Cairo and *Ichthyomyzon argenteus* (? *unicuspis* or both *unicuspis* and *castaneus*) from Lake Michigan and the larger rivers of the state. Nelson (1878) recorded *Petromyzon* (? *unicuspis* or *castaneus* or both) from Lake Michigan at Chicago. Jordan (1878) cited a specimen of *Ammocoetes argenteus* (? *unicuspis*) from Pekin and stated that *Ammocoetes hirudo* (? *castaneus*) occurred at Cairo, in the lower Ohio River, and in the Mississippi. Forbes (1884) listed host fishes and reported *Ichthyomyzon argenteus* (composite of *unicuspis* and *castaneus*) from the Illinois and Ohio rivers. Garman (1889) published a visual record of *Petromyzon castaneus* (? *unicuspis* or *castaneus*) from Quincy. Large (1903) cited *Ichthyomyzon castaneus* from Pekin and *Ichthyomyzon concolor* (composite) from the Illinois River and from Mount Carmel on the Wabash. Forbes and Richardson (1908 and 1920), Luce (1933), and O'Donnell (1935) reported *Ichthyomyzon concolor* (composite) from scattered localities in Illinois. O'Donnell (1935) suggested that *Ichthyomyzon* occurred in all Illinois streams having a drainage area exceeding 1,000 miles.

Hubbs and Trautman (1937) monographed the genus, recognizing three parasitic species

and describing for each of these, one nonparasitic derivative species. They re-examined a portion of the Forbes and Richardson series and other early collections of *Ichthyomyzon concolor* from the upper Mississippi Valley and found both *I. unicuspis* and *I. castaneus* commonly represented. In addition, they found a third population in the Ohio River system, for which they resurrected Jordan's name *bdellium*. In the Wabash drainage of Illinois (four localities) and Indiana (two additional localities), Hubbs and Trautman found only *I. bdellium*, prompting them to predict that the geographically complementary forms *bdellium* and *castaneus* would eventually be found to intergrade where their ranges meet near the mouth of the Ohio River.

Collections

In order to obtain as many lampreys as possible, we made personal contact with most of the principal commercial fishermen in Illinois, asking them to cooperate in the survey. Most of them expressed willingness to collect lampreys taken during their fishing operations. Cooperators were supplied with glass jars containing 10-percent formalin for the preservation of specimens. They were not asked to keep collection dates, although several of them recorded host fish and other details. Each fisherman was interviewed concerning the past and present status of lampreys in his locality.

The number of specimens available from a given locality reflects intensity of commercial fishing as well as abundance of the lampreys. Accordingly, special effort was made to enlist cooperators in areas where initial collections were inadequate. A total of 453 specimens of the genus *Ichthyomyzon* was collected in the 1949–59 survey, the majority of which were secured between 1951 and 1956. These specimens have been deposited in the Illinois Natural History Survey collection at Urbana.

According to the reports of the commercial fishermen, the principal host species during this study were: carp (*Cyprinus carpio*), buffalofishes (*Ictiobus* spp.), and paddlefish (*Polyodon spathula*) in the Ohio and Wabash rivers, and buffalofishes and carp in the Mississippi and Illinois Rivers.

Single specimens of lampreys were taken from the Kankakee, Skillet Fork, Vermilion (of the Wabash drainage), and Embarrass rivers. Two individuals were collected in the Big Muddy River and six were taken in the Little Wabash River. Most of the effort was spent on the Mississippi, Ohio, Wabash, and Illinois rivers, and sizable samples are available from each. Collection sites are depicted on Fig. 1.

Mississippi River.—An attempt was made to collect lampreys from each of the navigation pools between Alton and East Dubuque and in the uncanalized section between Alton and Cairo (Table 1). Commercial fishing operations were virtually non-existent between East St. Louis and Valmeyer because of the pollution of the St. Louis-Alton area (Starrett and Parr, 1951), and greatly curtailed for the same reason between Ste. Genevieve (Missouri) and Cairo.

Ohio River.—Collections were made between Shawneetown and Cairo (Table 2). Although no specimens were obtained at Cave in Rock, we were informed by local fishermen that lampreys were sometimes encountered on fishes taken from that section of the river.

Wabash River.—Collections were taken between Darwin and New Haven (Table 3). Commercial fishing in the Illinois section of the Wabash is conducted on a smaller scale than on the Illinois and Mississippi rivers (Starrett and Parr, 1951); and at Hutsonville and Grayville, all commercial operations are done on a part-time basis, thus accounting for the small collections available from these localities (Table 3).

Illinois River.—Most commercial fishing on the Illinois River is carried out between Putnam and Grafton. Because of the polluted conditions of the upper Illinois, there is no commercial fishing above Ottawa (Starrett and Parr, 1951). Although arrangements were made with fishermen to collect between Grafton and Ottawa, no specimens were received from localities above Peoria (Table 4).

Taxonomy and Distribution

The principal diagnostic characters for the three species of parasitic *Ichthyomyzon* can best be summarized in the following key, which is essentially the one constructed by Hubbs and Trautman:

1. Circumoral teeth almost invariably all unicuspid; supraoral cusps 1 to 4, usually 1 or 2; teeth in anterior row 2 to 4, usually 3; teeth in lateral rows 5 to 8, usually 6 or 7; disk proportionately large, its length usually contained 12.5 or less in total length; myomeres between last gill-slit

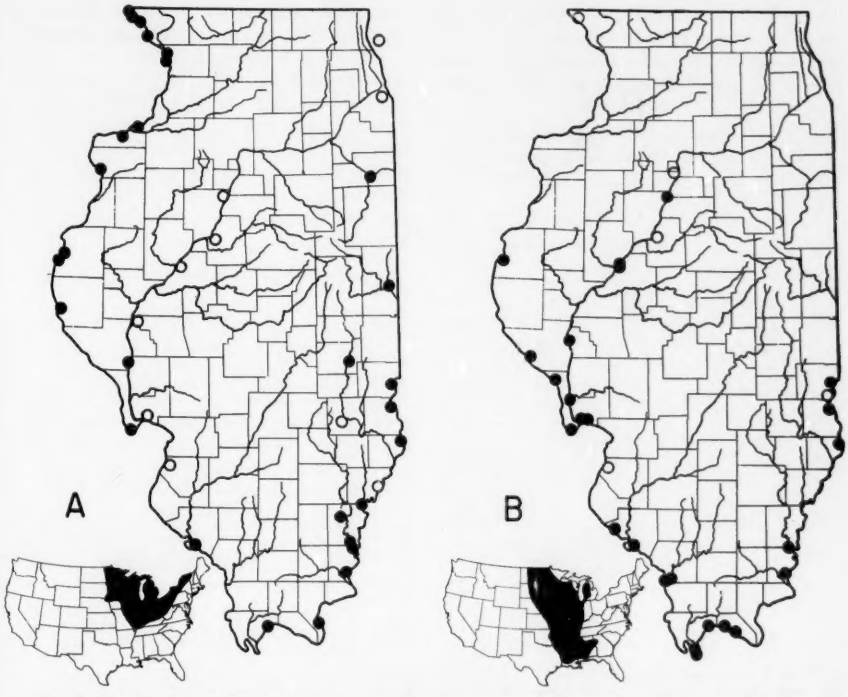

FIG. 1. Distribution of *Ichthyomyzon unicuspis* (A) and *I. castaneus* (B) in Illinois. Solid circles represent localities from which specimens were secured during this study; open circles, additional locality records based on specimens taken prior to our survey.

and anus usually between 49 and 52; transverse lingual lamina proportionately larger and moderately to strongly bilobed (with rare exception) ..... *Ichthyomyzon unicuspis.*

Circumoral teeth bicuspid in part (usually 4 to 8); supraoral cusps 2 or 3; teeth in anterior row 3 to 5, usually 4 or 5; teeth in lateral rows 6 to 11, usually 8 or 9; disk usually smaller, its length usually contained more than 12.5 times in total length; myomeres between last gill-slit and anus usually between 51 and 60; transverse lingual lamina proportionately smaller, linear to strongly bilobed 2

2. Transverse lingual lamina weakly bilobed or linear; myomeres 51 to 56; disk moderate in size, its length usually less than 14.3 times in total length; bicuspid circumorals usually 6 to 8 ..... *Ichthyomyzon castaneus.*

Transverse lingual lamina moderately to strongly bilobed; myomeres usually 55 to 60; disk rather small, its length usually contained more than 13.3 times in total length; biscuspids usually 7 or 8 ..... *Ichthyomyzon bdellium.*

The material available appears to contain only two species rather than three as expected. The silver lamprey, *Ichthyomyzon unicuspis* Hubbs and Trautman, is rather distinctive and requires only a summary of collections and analysis of variation. The chestnut lamprey, *I. castaneus* Girard, on the other hand, displays overlap in most characters with the closely related and superficially similar Ohio lamprey, *Ichthyomyzon bdellium* (Jordan), and accordingly requires more detailed treatment.

Ichthyomyzon unicuspis

A total of 313 lampreys taken in this study is referred to this species. Specimens ranged in total length from 4.5 to 14.0 inches. In the Mississippi River, the species was found to

be common in the East Dubuque-Savanna area but scarce below Oquawka. Only one specimen (at Chester) was found below the mouth of the Illinois River. Hubbs and Trautman also had but one record for this stretch of the river (also at Chester). In the Wabash River, *unicuspis* was more abundant than anywhere else in the state, Table 5, and it was rather common in the Ohio River near the mouth of the Wabash. On the lower Ohio, however, it was uncommon, only one specimen being found between Metropolis and the mouth of the river. Scattered collections are available from smaller rivers (Little Wabash, Skillet Fork, Kankakee, Embarrass, and Vermilion of the Wabash drainage). Collection sites are plotted in fig. 1A.

Distribution.—In addition to the collections taken by us, the species is known from several other parts of the state. Hubbs and Trautman examined specimens from the following additional localities: Chicago, Ha-

TABLE 1. NUMBERS OF PARASITIC LAMPREYS COLLECTED FROM THE MISSISSIPPI RIVER BETWEEN EAST DUBUQUE AND CAIRO, ILLINOIS, 1949–1957

Collecting Station[1]	Navigation Pool Number	*I. unicuspis*	*I. castaneus*
E. Dubuque	(11) & 12	85	0
Savanna	13	5	0
Sabula, Iowa	13	4	0
Albany	14	0	0
Moline	15[2]	1	0
Andalusia	16	1	0
New Boston	17 & 18	4	0
Oquawka	18	0	0
Gulfport	19	0	0
Dallas City	19[3]	0	0
Hamilton	19	0	0
"	20	1	1
Warsaw	20	1	1
Quincy	21	0	0
"	22	1	0
Rockport	24	0	10
Hamburg	25	0	8
Golden Eagle	26	1	5
Grafton	26	0	2
Ste. Genevieve, Missouri	B-26[4]	0	17
Chester	B-26	1	5
Grand Tower	B-26	0	10
Cairo	B-26	0	15

[1] Stations are in Illinois unless otherwise specified; pool 11 is in Iowa and Wisconsin.
[2] One specimen considered to be a hybrid *I. unicuspis* × *castaneus*.
[3] One lamprey from a carp later lost.
[4] Below navigation dam 26 at Alton. The B-26 section of the river between Cairo and Alton is not canalized.

TABLE 2. NUMBERS OF PARASITIC LAMPREYS COLLECTED FROM THE OHIO RIVER, 1951–1956

Collecting Station[1]	*I. unicuspis*	*I. castaneus*
Shawneetown	12	4
Cave in Rock	0	0
Bay City	3	0
Metropolis	0	1
Joppa	0	5
Olmsted	1	11
Cairo	0	9

[1] Towns are in Illinois, but collections are in Kentucky as that state owns entire river bordering Illinois.

TABLE 3. NUMBERS OF PARASITIC LAMPREYS COLLECTED FROM THE WABASH RIVER, ILLINOIS, 1951–1956

Collecting Station	*I. unicuspis*	*I. castaneus*
Darwin	43	8
Hutsonville	6	1
Russellville[1]	109	4
Grayville	3	0
New Haven	20	3

[1] All specimens from this station were collected in 1951.

TABLE 4. NUMBERS OF PARASITIC LAMPREYS COLLECTED FROM THE ILLINOIS RIVER, ILLINOIS, 1950–1959

Collecting Station	Navigation Pool	*I. unicuspis*	*I. castaneus*
Ottawa	Starved Rock	0	0
Depue	Peoria	0	0
Putnam	"	0	0
Lacon	"	0	0
Chillicothe	"	0	0
Peoria	"	0	1
Pekin	La Grange	0	0
Liverpool	"	0	0
Havana	"	0	5
Bath	"	0	0
Browning	"	0	0
Beardstown	"	0	0
Meredosia	Alton	0	0
Florence	"	0	5
Pearl	"	1	0
Hardin	"	0	2
Grafton	"	0	4

vana, Meredosia, Grafton, Newton, and Mount Carmel. Older published records, presumably referable to *unicuspis*, are available for Lake Michigan, Peoria, Pekin, and East St. Louis. Accordingly, the species appears to be state-wide in Illinois, but it is decidedly less common in the southern tip of the state, Fig. 1A. It is, however, restricted to moderate-sized and large rivers.

Geographic variation.—Inasmuch as *I. unicuspis* occurred in abundance only in extreme northwestern Illinois and in the Wabash River, adequate samples separated from each other by several hundred miles provide an excellent opportunity to discern variation trends (Table 5). No significant differences between the two samples were detected in counts of myomeres, supraoral cusps, teeth in anterior row, or teeth in the lateral rows. The mean numbers of infraoral cusps and teeth in the circumoral rows, however, were significantly different, although the low tooth count of the Mississippi River sample was partly due to the absence of the posterior part of the circumoral row in two specimens. Although the means for these characters show statistical significance compared with each other, our means vary only slightly from those given by Hubbs and Trautman. In fact, their means are almost exactly intermediate between our values in both characters.

Hubbs and Trautman consider the shape of the transverse lingual lamina to be one of the most useful diagnostic characters in the genus, and they characterize the lamina of *unicuspis* as moderately to strongly bilobed. We find the lamina to be moderately to strongly bilobed in 96.6 percent of the Wabash specimens and 91.3 percent of the Mississippi specimens and we concur that it is one of the best characters for separating species of *Ichthyomyzon*.

Two of our specimens possess bicuspid circumoral teeth, although in neither specimen does the number exceed two. Otherwise, the characters displayed by our series are typical of those described for the species by Hubbs and Trautman.

TABLE 5. MYOMERE AND TOOTH COUNTS IN *Ichthyomyzon unicuspis* COLLECTED FROM THE MISSISSIPPI RIVER AND FROM THE WABASH RIVER, ILLINOIS 1949–1957[1]

Character	Mississippi River		Wabash River		*t* value and degrees of freedom
	Count	S.D.	Count	S.D.	
Myomeres	**51.2**	1.44	**51.3**	1.63	0.446
	48–54		48–57		(95)
	68		*134*		
Supraoral cusps	**2.1**	0.43	**2.2**	0.53	1.667
	1–4		1–4		(127)
	93		*175*		
Infraoral cusps	**7.5**	1.07	**8.2**	1.18	4.950[2]
	5–11		5–11		(128)
	93		*179*		
Teeth in circumoral row	**18.3**	1.90	**19.6**	1.30	5.869[2]
	9–21		17–25		(127)
	91		*179*		
Teeth in anterior row	**3.2**	0.46	**3.1**	0.13	1.767
	2–4		2–4		(129)
	94		*180*		
Teeth in lateral rows	**6.9**	0.82	**6.9**	0.65	—
	4–9		4–9		
	184		*362*		

[1] Mean in boldface, range in lightface roman, and number of observations in italics. S. D. is one standard deviation.

[2] Designates a significant difference, for specified character, between specimens of *I. unicuspis* from the two rivers at 0.05 level for degrees of freedom indicated.

Ichthyomyzon castaneus

A total of 139 lampreys taken is referred to this species. Specimens ranged in total length from 4.75 to 14.0 inches. In the Mississippi River, *castaneus* was found to be fairly common between Rockport and Cairo (Tables 1 and 2). In the Wabash and Ohio rivers, the species was generally uncommon. In the Illinois River, it was similarly uncommon, except possibly in the lower part of the river. The five individuals from the Illinois at Havana do not indicate an abundance of *castaneus* in the area as much greater effort was expended to collect lampreys here than elsewhere in the state. Two specimens were secured in the lower Big Muddy River. All collection sites are plotted on Fig. 1B.

Distribution.—Hubbs and Trautman regarded the chestnut lamprey as state-wide in Illinois, except for the Ohio and Wabash drainages where it was presumably replaced by *I. bdellium*. They examined material from several localities where the species was taken by us, from Pekin, and from Galena (the holotype of *castaneus*). There is in addition an old published record for East St. Louis, and there are recently collected specimens in the Natural History Survey collection from Putnam and York. On the basis of recent collections, the species appears to occur

throughout the southern two-thirds of Illinois, including the Wabash and Ohio systems, Fig. 1B. The northernmost recent record is more than 100 miles south of the type locality of the species, thus suggesting a considerable change in the distribution of the species. Like *unicuspis*, the chestnut lamprey is restricted to larger rivers.

Geographic variation.—Variation in the more salient characters exhibited by our series are shown in Tables 6 and 7. In several cases, our counts (Table 6) are somewhat at variance (slightly higher counts for myomeres and bicuspids, for example) with those of Hubbs and Trautman, perhaps because our fairly large series are from a rather restricted part of the range rather than from the over-all range of the species. Several of these meristic characters have been rechecked and found to be reliable. A much greater departure is evident when our proportional characters (Table 7), are compared with those of Hubbs and Trautman; and we are at a loss to explain these discrepancies. For example, our means for tail length, body depth, snout length, disk length, and over-all length of gill-openings are higher than those indicated by Hubbs and Trautman for *castaneus* and much higher than those given for *bdellium*. Because of the shriveled condition or other poor state of preservation of occasional specimens, it was not possible to obtain complete data on every specimen, although full data were taken on the majority of the specimens. It is possible that both a considerable amount of distortion and the high frequency of very large lampreys account for our high values.

Meristic characters displayed by the Illinois and Mississippi river samples, although slightly higher than those given for *castaneus* by Hubbs and Trautman, are clearly much closer to those of *castaneus* than *bdellium*. Proportional characters are distinctly unlike those of *bdellium* and somewhat similar to those of *castaneus*. The transverse lingual lamina is linear or, much more frequently, slightly bilobed in our material from the Illinois River. It could be regarded as moderately bilobed in 2.6 percent of the specimens (otherwise typical *castaneus*) from the Mississippi River and linear or slightly bilobed in 97.4 percent. Inasmuch as the Illinois and Mississippi river samples are virtually alike and are from well within the range of *castaneus*, their counts can be considered as typical of the species. Moreover, our data tend to agree more closely with those of Hall and Moore (1954) and Bailey (1959) for series from the western part of the range of *castaneus* than with those of Hubbs and Trautman for series from the over-all range.

The variation of the Ohio River sample (Table 2) has received particularly careful scrutiny in view of Hubbs and Trautman's prediction that intergradation might be found in the area. We find no significant differences between Ohio and Mississippi river samples (Table 6); and on the basis of total characters, we must assign all specimens to *castaneus*. Meristic and proportional characters of the sample (Tables 6 and 7) were essentially the same as those of the Mississippi and other samples. Approximately 10.0 percent of the series possessed transverse lingual laminae that could be described as moderately bilobed, the remaining 90.0 percent being slightly curved or linear. Among the 10.0 percent, however, no specimen was clearly assignable to *bdellium*.

The Wabash River sample showed even less approach to *bdellium* in meristic and proportional characters (Tables 6 and 7). Tooth counts in the anterior and lateral rows displayed statistical significance when compared to those of the Mississippi sample but showed no affinities in this respect with *bdellium*. Approximately 16.7 percent possessed lingual laminae that could be regarded as moderately bilobed, but the arbitrary division between moderately and slightly bilobed is extremely subjective and no bimodality is suggested.

Despite the availability of good samples, it is difficult to evaluate the data in relation to intergradation or introgression of *castaneus* and *bdellium*. An attempt has been made to discern variation trends that might indicate *bdellium* influence within Illinois populations by lumping Illinois-Mississippi samples and Ohio-Wabash samples and comparing their means with each other. The results for two of the four diagnostic characters are shown in Fig. 2. In myomere counts, the means for the Illinois-Mississippi and the Ohio-Wabash samples are somewhat intermediate between those of *castaneus* and *bdellium*, although decidedly closer to the mean of *castaneus*. They differ slightly from each other but differ significantly from the means of both *castaneus* and *bdellium*. In bicuspid circumoral counts, the same trend is evident except that statistical significance is seen only by the mean difference between *castaneus* and *bdellium*.

Shape of the transverse lingual lamina has been discussed above. The fourth "key character" is relative disk length. The means for the two Illinois samples are not intermediate

TABLE 6. ANALYSIS OF MYOMERE AND TOOTH COUNTS IN *Ichthyomyzon castaneus*[1]

Character	Mississippi River		Illinois River			Ohio River			Wabash River		
	Count	S.D.	Count	S.D.	*t* value and degrees of freedom	Count	S.D.	*t* value and degrees of freedom	Count	S.D.	*t* value and degrees of freedom
Myomeres	**54.1**	1.27	**53.7**	2.02	0.689	**54.3**	1.55	0.647	**54.1**	1.35	—
	51–58		49–56		(29)	51–57		(37)	52–57		
	69		*13*			*21*			*14*		
Bicuspids	**6.7**	1.89	**7.2**	2.43	0.795	**7.1**	2.12	0.903	**6.6**	1.50	0.230
	1–10		1–11		(34)	1–13		(46)	2–9		(33)
	74		*17*			*30*			*16*		
Supraoral cusps	**2.5**	0.56	**2.5**	0.52	—	**2.5**	0.68	—	**2.4**	0.51	0.699
	2–4		2–3			2–5			2–3		(33)
	74		*16*			*30*			*16*		
Infraoral cusps	**8.9**	1.08	**9.0**	1.41	0.267	**9.0**	1.25	0.383	**8.6**	1.21	0.914
	5–13		7–12		(33)	6–11		(45)	7–11		(33)
	72		*16*			*30*			*16*		
Teeth in circumoral row	**21.1**	0.96	**20.8**	1.05	1.052	**21.2**	0.98	0.468	**21.5**	1.02	1.398
	19–25		19–23		(33)	20–24		(45)	20–24		(32)
	74		*16*			*29*			*15*		
Teeth in anterior row	**4.6**	0.54	**4.7**	0.48	0.738	**4.5**	0.57	0.822	**4.9**	0.44	2.366[2]
	3–6		4–5		(33)	3–5		(46)	4–6		(33)
	73		*16*			*30*			*16*		
Teeth in lateral rows	**8.7**	0.69	**8.5**	0.72	1.437	**8.7**	0.70	—	**9.3**	1.14	2.868[2]
	8–11		7–10		(68)	8–10			7–11		(68)
	148		*32*			*60*			*32*		

[1] Statistical tests were made between Mississippi River counts and those from specimens collected from each of the other rivers. Mean in boldface, range in lightface roman, and number of observations in italics. S. D. is one standard deviation.
[2] Designates a significant difference, for specified character, between specimens from the Mississippi River and the Wabash River at 0.05 level for degrees of freedom indicated.

TABLE 7. LENGTHS OF *Ichthyomyzon castaneus*[1]

River	No. of Specimens	Total Length		Tail length/ Total length	Body depth/ Total length	Snout length/ Total length	Disk length/ Total length	Gill openings length over-all
		Inches	Millimeters					
Illinois	16	5.0–13.0	148–320	**291**	**89**	**92**	**75**	**110**
				266–329	78–105	75–110	63–100	94–123
Mississippi	70	5.0–13.5	119–332	**293**	**88**	**93**	**82**	**104**
				248–332	68–116	76–116	54–103	73–126
Ohio	23	5.0–13.0	130–317	**288**	**91**	**97**	**85**	**106**
				232–326	75–106	84–119	75–99	95–119
Wabash	14	6.0–14.0	153–345	**284**	**93**	**98**	**83**	**106**
				260–317	75–115	90–106	72–93	94–115
I. castaneus	85	—	105–310	**282**	**82**	**90**	**77**	**94**
				250–335	59–109	75–109	63–91	83–114
I. bdellium	46	—	69–259	**274**	**73**	**86**	**69**	**89**
				214–311	55–92	75–94	62–77	77–107

[1] *Ichthyomyzon castaneus* collected from rivers of Illinois, 1949–1959, shown with lengths recorded for *I. castaneus* and *I. bdellium* by Hubbs and Trautman. Mean in boldface, range in lightface roman.

between those of *castaneus* and *bdellium* but higher than either and particularly far removed from the mean of *bdellium*. Average disk size is least in *bdellium*, next least in *castaneus*, relatively large in the Illinois-Mississippi sample, and greatest of all in the Ohio-Wabash series.

In summary, there is a very slight tendency

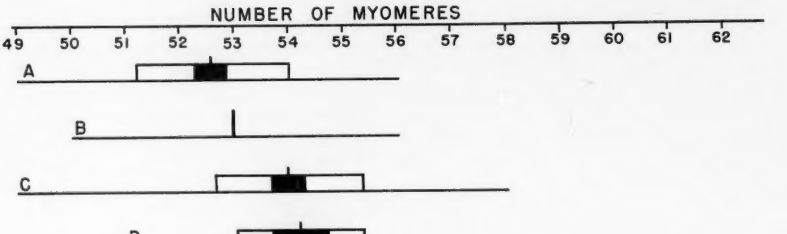

Fig. 2. Summary of myomere counts (above) and biscuspid circumoral counts (below) for five samples of lampreys. A, *Ichthyomyzon castaneus*, computed from raw data of Hubbs and Trautman; B, *I. castaneus* from Oklahoma, from data of Hall and Moore; C, *I. castaneus* from the Illinois and Mississippi rivers; D, *I. castaneus* from the Ohio and Wabash rivers; and E, *Ichthyomyzon bdellium*, computed from data of Hubbs and Trautman. The vertical line represents the mean; horizontal line, observed range; hollow rectangle, one standard deviation to either side of the mean; solid rectangle, two standard errors to either side of the mean.

toward *bdellium* in the shape of the lamina and in mean counts of myomeres and bicuspid circumorals; but because the trend is slight rather than pronounced as could be expected if interbreeding occurred in the Ohio-Wabash system, we are inclined to believe that *castaneus* is more variable than formerly supposed and that *bdellium* influence is not discernible in Illinois lampreys.

Hubbs and Trautman found *bdellium* to the complete exclusion of *castaneus* in the Wabash Valley of Illinois and throughout Indiana. We find no *bdellium* at all in Illinois. Gerking (1945 and 1955) reported recent collections in Indiana of *castaneus* from Lawrence, Green, and LaPorte counties and *bdellium* only from Pulaski and Kosciusko counties.

Four of the five Wabash Valley specimens identified as *I. bdellium* by Hubbs and Trautman are extant and have been re-examined by us. One of them (USNM 66882 from Terre Haute, Indiana) is clearly referable to *bdellium*; the other three (UMMZ 55333 from Charleston, Illinois; UMMZ 107039 from Newton, Illinois; and USNM 17761 from Mount Carmel, Illinois) are intermediate and within the variational range of both *bdellium* and *castaneus* and cannot be assigned with certainty by us. All four are quite old, faded, and in a rather poor state of preservation.

Hybridization

One specimen, 9.5 inches in total length, was collected from the Mississippi River at Moline, Navigation Pool 15, that seems to possess characteristics of both *unicuspis* and *castaneus*. It shares with *unicuspis* a low myomere count (49) and a deeply bilobed transverse lingual lamina. It agrees with *castaneus* in having eight bicuspid teeth in the circumoral row and five teeth in the anterior row. On the basis of these data, we have tentatively considered the specimen a *unicuspis* × *castaneus* hybrid.

Discussion

The data available indicate that although the geographic ranges of *I. unicuspis* and *castaneus* overlap widely, in numerical distribution there is little overlap (Tables 1–4). Hubbs and Trautman found *unicuspis* forming what they termed as a "real population" in Lake Pepin, Minnesota, where 39 specimens of *unicuspis* were taken to one of *castaneus*. Farther down the Mississippi, both species are known from the Mississippi in Allamakee County, Iowa (Harlan and Speaker, 1956), although their numerical relationship is not known to us. The current dearth of records for northwestern Illinois of *I. castaneus* (including the vicinity of its type locality) is not readily explained.

The scarcity of lampreys in general from the Mississippi River between East Dubuque-Savanna and Rockport may be related to the type of tributary streams in the region. The watershed below Savanna is glaciated, parts of that in the East Dubuque-Savanna area and that between Rockport and Cairo are unglaciated. Tributary streams of the Mississippi River in the unglaciated areas usually have steeper gradients, a greater quantity of clean gravel bottoms, and more riffles, habitats presumably better suited for lamprey spawning than the muddy, slow-moving streams of the prairie region.

In the Illinois River lampreys were scarce except in the lower part where the watershed was unglaciated. Commercial fishermen believe that lampreys were more abundant in the Illinois below Peoria 25 or 30 years ago than in the present decade. The late Mr. George Phillips informed us that before 1900 lampreys were seen quite regularly during commercial fishing operations in the upper part of the Illinois River near Ottawa. He believed that the decrease and final disappearance of lampreys from that part of the river was associated with the increase in pollution from the Chicago area after 1900. Possibly the increased amount of silt now carried and deposited in the streams has had an adverse effect upon spawning success of lampreys in the tributary streams. However, Forbes and Richardson (1908, 1920) did not regard the lamprey as common anywhere in the Illinois River.

Although the abundance of lampreys is generally greater in the vicinity of unglaciated areas, the Wabash River is an exception; for it was glaciated during the Illinoian stage, and during our survey appeared to have sluggish streams as tributaries that were quite unsuitable for lamprey spawning. We made no attempt to examine the tributary streams on the Indiana side of the river, and it is possible that the White River and its tributaries might be a potential source of the comparatively great number of lampreys found in the Wabash River proper. Parts of the Wabash River itself may be used for spawning by lampreys.

Summary

A total of 453 specimens of parasitic lampreys belonging to othe genus *Ichthyomyzon* was collected from the Illinois rivers, between 1949 and 1959. These specimens were secured largely from the Mississippi, Illinois, Ohio, and Wabash rivers, but smaller lots were obtained from the Little Wabash, Skillet Fork, Big Muddy, Kankakee, Embarrass, and Vermilion (of the Wabash drainage). A dubious record for the Du Page River was obtained for the sea lamprey, which otherwise is known in Illinois waters only in Lake Michigan.

Of the 453 specimens of *Ichthyomyzon*, only two species are represented, *Ichthyomyzon unicuspis* and *I. castaneus*. The former species was found to be most abundant in the East Dubuque-Savanna region of the Mississippi River and in the Wabash River; the latter, in the lower reaches of the Mississippi, Ohio, and Illinois rivers. Lampreys were scarce in the Savanna to Rockport section of the Mississippi and in the Illinois River above Florence. A partial explanation is provided by the absence of suitable spawning grounds in the tributaries over much of glaciated Illinois.

Apart from a certain amount of doubt regarding the interpretation of "moderately" versus "slightly" in describing the bilobation of the transverse lingual lamina, and slightly higher averages in myomere counts, there is no evidence that *I. bdellium* presently occurs in Illinois or extreme western Indiana. Nor is there evidence that a population of *castaneus* × *bdellium* intergrades occurs in the Wabash and lower Ohio rivers. It appears that *I. bdellium* has a more eastern distribution at present. Whether *bdellium* is specifically or subspecifically distinct from *castaneus* must await the availability of series from southern Indiana.

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Ichthyological Notes

UNUSUAL PIGMENTATION IN THE FLOUNDER *PARALICHTHYS LETHOSTIGMA*.—A southern flounder with unusual pigmentation was gigged in shallow water along

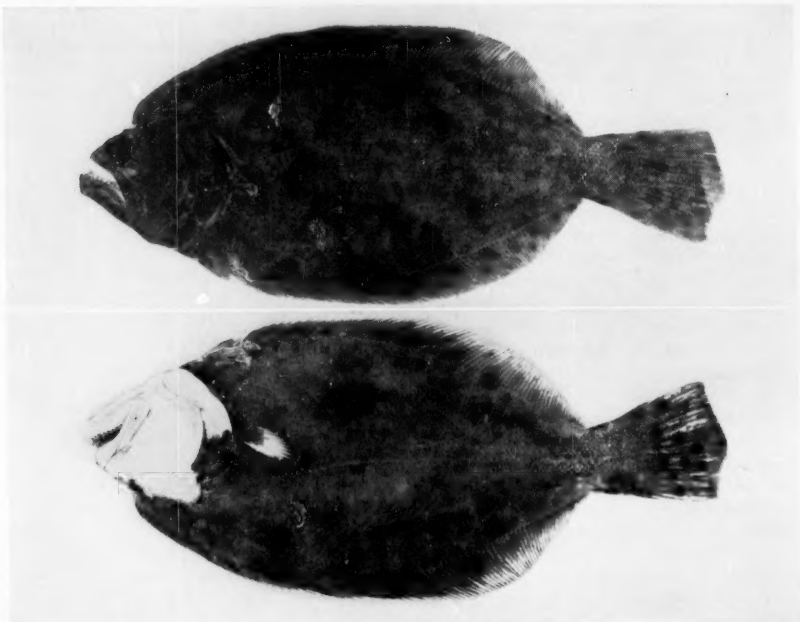

Fig. 1. Unusual pigmentation in *Paralichthys lethostigma*. Top: the normal pigmentation of the upper side; and bottom: the abnormally pigmented underside.

the shore of Harkers Island, North Carolina, on May 1, 1960, and brought to the laboratory by Mr. A. P. Stewart. Except for the pigmentation, the southern flounder, *Paralichthys lethostigma*, measuring 376 mm., was typical of the species, which is common in the region. Normally, flounders have pigment only on the upper side, the blind side remaining white. As may be seen from Fig. 1, this specimen not only has the usual pigmentation on the upper side, but in addition, except for the head and white pectoral fin, has the under side also heavily pigmented. The fish was a novelty to the Harkers Island fishermen; none of those questioned had seen anything like it before. A survey of the literature revealed only one reference to this abnormal pigmentation on the under side. Pearson (1932, *Rept. U. S. Bur. Fish. (10):24*), in discussing the flounder catch in the winter trawl fishery off the Outer Banks of North Carolina, says, "Incidentally, several summer flounders, heavily pigmented on both sides with black, were brought in by the fishermen as oddities." The winter trawlers, at the time of Pearson's report, operated in two areas: (1) Off Bodie Island, well north of Cape Hatteras, in 20–50 fathoms, and (2) off Ocrakoke Inlet, south of Cape Hatteras, within the 20 fathom line. Pearson does not state in which area the abnormally pigmented flounders were taken. Flounders are common in both areas. Nor does Pearson describe the extent of pigmentation on the blind side, so it is not known if the ones he reports were pigmented in a similar manner to the one here described. By way of Pamlico Sound and Core Sound, Harkers Island is roughly forty nautical miles from the nearer of the two fishing grounds, so fish could readily get from one area to another.—I. E. Gray, *Department of Zoology, Duke University, Durham, North Carolina.*

OBSERVATIONS ON THE FECUNDITY OF THE TOMCOD, *MICROGADUS TOMCOD* (Walbaum).—The tomcod, a relatively common inshore fish, is much sought after by Massachusetts fishermen, especially during the winter months. Little is known, however, of the fecundity of this fish and such data are presented here.

A total of 100 tomcod used in this study were collected, using hooks baited with the sea worm, *Nereis virens* Sars, along the coast of Hull, Massachusetts, during three sampling trips in October, November, and December 1959. The sex ratio was approximately one male to every three females (27 ♂ to 73 ♀) in the total sample. In the laboratory the gonads from females were removed, weighed to the nearest tenth of a gram and measured in length to the nearest millime-

Table 1. Average Number of Ova Produced by Tomcod, *Microgadus tomcod*

Date	Sample number[1]	Paired ovary number	Weight of paired ovary (grams)	Average weight	Number of ova equal to one gram	Total number of ova	Average number of ova	Length of ovary mass (mm.)	Average length	Length of fish (mm.)	Average length
10/25/59	1	1	3.3		3,506	11,570		35		205	
		2	6.3		2,700	17,010		50		340	
		3	6.2		2,750	17,050		47		180	
		4	2.2		2,579	5,674		23		170	
		5	2.4		5,841	14,018		33		202	
			20.4	4.08	Total	65,322	13,064	188	37.6	1,097	219
11/14/59	2	1	18.7		1,026	19,186		55		215	
		2	14.1		1,392	19,627		55		255	
		3	6.6		2,112	13,939		40		205	
		4	12.6		1,717	21,634		50		220	
		5	10.4		1,734	18,034		50		190	
			62.4	12.48	Total	92,420	18,484	250	50.0	1,085	217
12/12/59	3	1	10.4		488	5,075		100		208	
		2	44.2		560	24,752		70		210	
		3	48.7		610	29,707		75		221	
		4	33.0		590	19,470		75		225	
		5	56.5		560	31,640		85		220	
			192.8	38.56	Total	110,644	22,129	405	81.0	1,084	217
	1 + 2 + 3			18.37			17,892		56.2		
	2 + 3			25.52			20,307		65.5		

[1] Samples two and three were taken during the periods closest to spawning and represent the closest approximation of actual spawning characteristics.

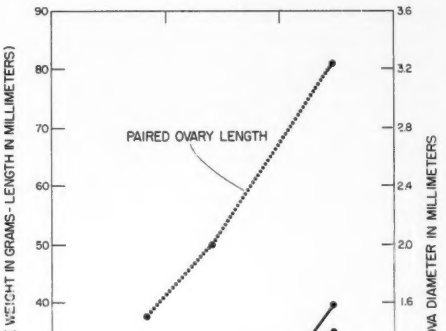

Fig. 1. Averages of ova diameter and paired ovary weight and length of tomcod, *Microgadus tomcod*, collected from October to December 1959.

ter. Examination was made for the presence of parasites, ruptured blood vessels, and general gonad form before preservation in 10 percent formalin solution.

The gonads were stored for a period of two weeks, after which time five pairs of ovaries from each of the three samples were chosen at random for further examination. From each pair, the number of ova in one gram was determined. The total number of ova present in each pair of ovaries was then estimated by multiplying the number of ova in one gram by the total weight of the pair. The average total number for each of the three samples, and the average of these averages, are given in Table 1. The mature tomcod produces an average of 20,000 ova, with a minimum of 6,000 and a maximum of 30,000. The ova showed an average increase in diameter from 0.6 mm. in October to 1.4 mm. in December (Fig. 1). Fig. 1 also shows the increase in ovary weight and length from the early developmental stages in October to December, when the peak of spawning activity is reached. The average weight of the mature paired ovary was 26 grams and the average length was 66 mm. (Table 1).

Bigelow and Schroeder (1953, *Fish. Bull. U. S. Fish and Wild. Serv. 53(74):577*) state that the spawning season of the tomcod begins in November and extends into February, with the peak beginning in late December. Our data are in agreement with their findings. A number of fertilized ova collected from Hull Harbor, December 19, had a conspicuous oil globule and distinguishable eye bulge. The ovaries of fish sampled increased in both length and weight from October to December. This increase seems to result from an increase in individual ova diamter (Fig. 1) and numbers of developing ova (Table 1).

Examination of mature eggs taken from a group of ovaries of the December 12th sample, showed an ova diameter of 1.4 mm. to 1.5 mm. This value agrees with the 1.5 diameter of newly spawned ova reported by Bigelow and Schroeder (*ibid*).

No significant observations were made on the presence of parasites and ruptured blood vessels; only gonad form was found to differ during the three months of sampling. The increase in gonad size seemed to constrict the alimentary canal and other internal organs; however, no critical analysis of this condition was made.—EVERETT SCHANER, *Oceanographic Laboratory, Randolph High School, Randolph, Massachusetts,* KENNETH SHERMAN,[1] *United States Fish and Wildlife Service, Bureau of Commercial Fisheries, Honolulu, Hawaii.*

THE TYPE LOCALITY OF *GASTEROSTEUS ACULEATUS WILLIAMSONI* AND ITS SIGNIFICANCE IN THE TAXONOMY OF CALIFORNIAN STICKLEBACKS.—Under the name *Gasterosteus williamsoni*, Girard (1854, *Proc. Acad. Nat. Sci. Phila. 77:133* described this smooth-sided stickleback from Williamson's Pass, California, but was unable to specify the locality at that time. Later, however, Williamson (1855, *Pac. R. R. Expl. and Surv. 5(I):30*), for whom both the fish and the pass were named, stated that Williamson's Pass leads into the coastal Santa Clara River. This intermittent stream rises on the northeastern slopes of the San Gabriel Range and flows westward for about 75 miles through Los Angeles and Ventura counties to enter the Pacific just south of Ventura. As shown on a map by Blake (1857, *Pac. R. R. Expl. and Surv. 5(2):opp. p. 197*), the pass lies just west of 118° N. Long., and slightly north of 34° 30′ W. Lat., which places its summit near the railroad station of Vincent, 5 miles south of Palmdale, in what is now mapped as Soledad Canyon.

A reference to the creek in the valley of the pass, from which the eight type specimens must have come, was made by Blake (*op. cit.*: 69, 72), who wrote that the stream bed is dry "for a long

[1] Formerly on the staff as biology instructor at Randolph High School, Randolph, Massachusetts. Published by permission of the Director, U. S. Bureau of Commercial Fisheries.

distance in the lower part of the pass" during the dry season. At the present time the river bed retains permanent water in short stretches and in isolated pools only in the upper part of Soledad Canyon, according to local testimony and personal observations. Furthermore, in his summary report, Girard (1858, *Pac. R. R. Expl. and Surv. 10:94*) briefly described the habitat of *G. a. williamsoni* as follows: "The waters from this place reach the Pacific during the rainy season. In the dry season the waters remain in isolated pools." Waring (1915, *U. S. Geol. Surv. Water-Supply Pap. 338:353*) described Kentucky Springs, as one of the important source springs in this part of Soledad Canyon, lying about 4 miles south of Vincent and yielding, in July, 1909, a flow of about 10 gallons a minute. Very probably these springs formed an important contribution to the flow that maintained the population of *Gasterosteus* sampled in 1853.

From these data the type locality of the unarmored threespine stickleback may be stated to lie in the upper part of Santa Clara River in Soledad Canyon, probably between Lang and Acton, about 12 to 20 miles east of Saugus, in Los Angeles County, California (see U. S. G. S. Tujunga Quadrangle, 1900 edition).

The importance of a precise determination of the type locality of this fish becomes significant in the light of later studies of the sticklebacks of the region. Because it was then not understood that distinctive genetic stocks of *Gasterosteus aculeatus* inhabit the Santa Clara River, Regan (1909, *Ann. and Mag. Nat. Hist. ser. 8, vol. 4:437*) was led to describe a new species, *Gasterosteus santae-annae*, from the Santa Ana River of southern California, chiefly on the basis of fewer vertebrae (29 versus 31–32 in *williamsoni*) and the position of the first dorsal spine with respect to the bases of the pectoral and pelvic fins. Regan's comparison of the Santa Ana population was made with supposed topotypes of *G. a. williamsoni*, whereas actually his Santa Clara River sample represents intergrades between the partly-plated form and the smooth-sided type. This interpretation was made by Rutter (1896, *Proc. Calif. Acad. Sci. ser. 2, vol. 6:252*) for the Santa Clara River specimens he examined (from which Regan's material was derived), and my studies support this viewpoint. Snyder (1913, *Bull. U. S. Bur. Fish. 32 (1912):71*) concluded that Rutter's data showed that it is impossible to distinguish the smooth-sided form (Rutter's *G. w. williamsoni*) on the basis of the number of lateral plates. The source of this mistake is now evident, for, as he clearly indicated, Rutter never had specimens of the true *williamsoni* from the Santa Clara drainage.

Snyder also predicted "that further collecting in the Santa Ana would result in securing specimens that are more fully armed." This prediction is conclusively disproven by the following original data on the lateral armature of populations from the Los Angeles Plain (plates counted on both sides in most specimens): Santa Ana River (208 specimens), 0 (405), 1 (6), 2 (4), 3 (1), ave. 0.04; San Gabriel River (294 specimens), 0 (249), 1 (38), 2 (39), 3 (4), 4 (1), ave. 0.39; and Los Angeles River (38 specimens), 0 (58), 1 (8), 2 (9), 3 (1), ave. 0.38. Ninety topotypes of *G. a. williamsoni* have the following number of lateral plates: 0 (164), 1 (11), 2 (5), ave. 0.12. The average number of plates for a random sample of 10 specimens of *williamsoni* is fewer than 1 (based on 2,097 counts).

The number of vertebrae, including the hypural complex (which was excluded by Regan), varies from 29 to 32 and averages 30.55 in 80 specimens of "*santae-annae*"; in 78 topotypes of *williamsoni* the number varies from 31 to 33 and averages 31.50 (there is about a 50 percent overlap at 31 vertebrae). This average difference of one vertebra may be of biological significance, indicating recent and probably continuing gene flow between the more fully plated form of the Santa Clara River (typically with 32 vertebrae) and the essentially naked form of the same river system. In contrast, a long period would appear to have elapsed without such contact between these types in the Los Angeles Plain region. The difference in the position of the first dorsal spine described by Regan seems to hold on comparison between topotypes of *williamsoni* and specimens from the Los Angeles Plain.

It is pertinent to note that the fossil stickleback *Gasterosteus doryssus* (Jordan) from the early Pliocene "Lahontan beds" (= Truckee Formation) near Hazen, Nevada (see Miller, 1955, *Occ. Pap. Mus. Zool. Univ. Mich. No. 568.12*, regarding age), was also a freshwater form with few or no lateral plates.

In Belgium, the populations of *Gasterosteus aculeatus* that possess numerous lateral plates are physiologically adapted to higher salinities, those with few plates to fresh water. Ecological and morphological characters are bimodal and closely correlated, so that two main categories may be distinguished (Heuts, 1947, *Evolution 1: 101–2*). Studies of this type are sorely needed for the American populations.

Jordan and Hubbs (1925, *Mem. Carnegie Mus. 10:201*) further indicated the uncertainty over the precise type locality of *G. a. williamsoni* and considered *G. santae-annae* to be a synonym of *williamsoni* (in which view I concur). They interpreted the range of this form as "the Santa

Ana system of streams of Southern California..." Hubbs (1929, *Occ. Pap. Mus. Zool. Univ. Mich. 199:4*) also regarded the Santa Clara River to lie just northward of the range of *williamsoni*. Miller (1939, *Copeia (3):168*) referred the stickleback of San Juan Creek, Orange County, California, to *williamsoni*, but since that population has from 1 to 6 plates, usually 3 to 5, and averages 3.78 in 153 specimens (206 counts), it clearly does not represent the unarmored form.

Repeated collecting in the Santa Clara River basin from 1939 to 1945 resulted in the discovery of remnant populations of *G. a. williamsoni* in certain parts of the drainage, although this fish eluded us in the region of the type locality. Finally, in 1946, almost a century after the original collection was taken, the late Ralph G. Miller secured topotypes, and a large topotypic series was preserved in 1948. Since only one of the 8 syntypes has been found and since the fresh material agrees very well with this specimen and with Girard's description of *williamsoni*, the new specimens provide a firm basis for uniting *santae-annae* and *williamsoni*.

Although this essentially naked and permanently fluviatile stickleback may now be extinct on the Los Angeles Plain (Miller, 1961, *Pap. Mich. Acad. Sci., Arts, and Letters 46 [1960], in* press), it presumably still persists in the headwaters (and certain other parts) of the Santa Clara River (where last observed in 1951); it has also become established, presumably through introduction as bait, in the Mojave River (where it was first noted in 1940) and perhaps in some other streams flowing onto the Mojave Desert from the northern slopes of the San Gabriel Range. It has also been collected in the Santa Maria River drainage (Alamo Creek and Huasna River) in San Luis Obispo County, California, where I feel that it is likely native.

Although Münzing (1959, *Int. Rev. Ges. Hydrobiol. 44, (3):323*) seems to have suggested the equivalence of *G. a. williamsoni* with *G. a. leiurus* Cuvier, I am not prepared to accept this allocation without a thorough comparison between the naked forms of southern Europe and southern California.

I am indebted to the following for assistance in making material available: Howard R. Hill, Malcolm Miller, George S. Myers, Leonard P. Schultz, Margaret H. Storey and Loren P. Woods.
—ROBERT RUSH MILLER, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

RECENT SHARK ATTACK OFF THE EAST COAST OF SOUTH AFRICA, APRIL, 1960.—A shark attacked Michael Hely, aged 16, at 3.35 pm on an overcast day on April 30, 1960, while he was swimming in slightly murky water about 6 feet deep on an incoming tide at Inyoni Rocks near Amanzimtoti, Natal. The temperature of the water was 71° F. Hely was wearing a pair of homemade red and yellow swimming trunks and carried a silver ring on a finger of his right hand.

While treading water in a channel about 30 feet from the shore Hely felt something touch his right leg and thought he had brushed against a stick or some other submerged object. Immediately afterwards he felt pressure and a tug on his right arm and he was pulled downwards below the surface of the water. He realized that he was being attacked by a shark and began a violent struggle for his life. He recalls a violent and frenzied, but short underwater battle with his assailant. Then he broke free, came to the surface and began swimming for the shore. In his opinion the shark was swimming with him but to his knowledge no further attack took place. Hely reached the shore and staggered out unaided. At no time did he feel any sensation of pain.

Hely was carried to the Lifesaver's Hut and 12 minutes after the attack he was attended by Dr. W. J. Macnabb, a doctor from Amanzimtoti. According to Dr. Macnabb he was in shock but to a lesser degree than might have been expected. Bleeding had almost ceased at this stage. Hely's blood pressure was 90/40 and he had a very fast pulse. His wounds consisted of bites on the right lower limb, right forearm and hand, finger on left hand and right lumbar region. The latter wound was very serious and included extensive damage and removal of skin, muscle and tissues resulting in the exposure of the abdominal cavity and ilium (Fig. 1). Hely remained conscious on the beach, was given ¼ grain morphia intravenously and all his limbs were raised to allow flow of blood to the trunk region. He responded well to this treatment and was quiescent and rational when he left the beach for Addington Hospital, Durban, 16 miles distant. Hely was completely collapsed on arrival at approximately 4.15 pm.

Statements made by witnesses indicated that the shark responsible for the attack on Hely was approximately 6–7 feet in length. A blackfin shark, *Eulamia limbata* Müller and Henle [= *Carcharhinus limbatus* (Müller and Henle)], was caught in the immediate vicinity on the day following the attack. Unfortunately, this specimen was not obtained for examination.

On 6th May by arrangement with Mr. A. C. Copley, the surgeon in charge and with the kind permission of the Superintendent of Addington Hospital, Dr. Tanschel, I was permitted to be

Fig. 1. View of a shark wound in the right flank of a 16-year old boy taken 6 days after the attack, showing extensive removal of muscle tissue, exposure of the iliac crest and tooth-made lacerations.

present in the operating theatre when Hely's wounds were being dressed.

Preparations for the examination of Hely's wounds in the theatre, with a view to establishing the species of shark responsible, included the selection of the teeth and jaws of three different species of shark of approximate total length 7 feet. The greatest possible range in the type of dentition shown by man-eating types of sharks occurring in the Durban area were selected. The teeth varied from the elongated slender type found in the ragged tooth shark, *Carcharias taurus* Rafinesque, to the shorter, wider, triangular teeth with the serrated edge of the grey type shark, eg. *Eulamia lamia* (Blainville) [= *Carcharhinus lamia* (Blainville)]. The teeth of the blackfin shark are of a type roughly intermediate between the two.

Bite patterns of the three types of jaws were obtained by pressing the teeth into simulated limbs covered with paper. The clear-cut tooth pattern in the wound in the right lower limb indicated sharply the shape and size of the jaws of the shark and enabled measurements to be made. The measurements fitted closely with those taken from specimens of the jaws of the sharks available and confirmed the observation that the total length of the shark in question was indeed between 6 and 7 feet.

Examination of skin punctures made by teeth in the right leg and arm gave no clear indication as to the type of tooth involved. Tooth marks on the skin of Hely's back and grooves in the exposed hip bone indicated that the teeth that had caused the wounds were probably of the slender type. Further detailed examination of the wounds and in particular the grooves on the iliac crest made it evident that the teeth involved were almost certainly those of the much elongated slender type belonging to the ragged toothed shark, *Carcharias taurus*.—DAVID H. DAVIES, *Oceanographic Research Institute, P. O. Box 736, Durban, Natal, Union of South Africa.*

A REDESCRIPTION OF *LETHARCHUS PACIFICUS*, A SNAKE EEL FROM THE EASTERN PACIFIC OCEAN.—The second author sent to the United States National Museum, in 1959, two large eel specimens, 557 and 564 mm. in total length (USNM 179855 and MCZ 40432, respectively) for verification of his identification as *Letharchus pacificus*. They were collected by him off the old U.S. Naval docks on Baltra Island, Galapagos, in 1956. When studied by the first author and compared with other specimens of *L. pacificus*, they were found to have such a strikingly different color pattern from probable juveniles of this species that a redescription and carefully drawn figures were needed to clarify the status of this little known eel.

Osburn and Nichols (1916, *Bull Amer. Mus. Nat. Hist. 25(6):146, fig. 3.*) described *Letharchus pacificus* from the "5½ inches" long holotype, USNM 87540, collected by the *Albatross* on March 23, 1911, off Cape San Lucas. This speci-

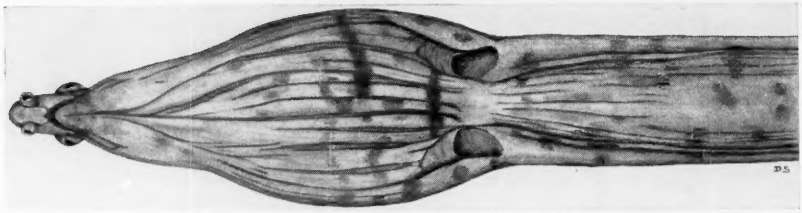

Fig. 1. Under side of head of *Letharchus pacificus*. Note the double dermal folds around opercular openings.

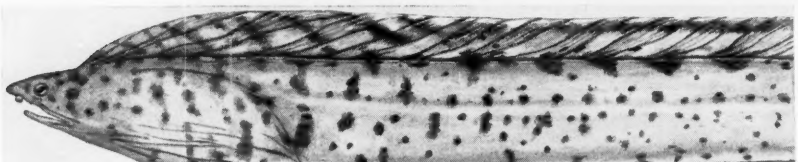

Fig. 2. Lateral view of *Letharchus pacificus*, MCZ 40432. Both drawings by Dorothea B. Schultz.

TABLE 1. CERTAIN MEASUREMENTS OF *Letharchus pacificus*, RECORDED IN THOUSANDTHS OF THE DISTANCE FROM TIP OF SNOUT TO ANUS

Total length in mm.	136	207	292	557	564
Tip of snout to anus mm.	88	129	180	345	358
Snout tip to dorsal origin	49	43	37	29	28
Anus to anal origin	438	512	528	550	502
Snout tip to front of edge gill opening	127	112	110	91	92
Snout tip to rear edge gill opening	143	132	121	98	106
Length of snout	18	16	13	10	11
Diameter of eye	9	8	6	4	5
Greatest depth of body	33	42	42	45	42
Tip of chin to rictus	23	18	16	16	15
Width between bases of anterior nasal tubes	3	3	3	3	3
Tip of chin to rear edge of base of anterior nasal tube.	5	5	5	3	3
Interorbital space	8	9	10	9	8
Anal fin origin to tip of tail	106	93	95	75	67

men now measures 136 mm. in total length. The original description and the figure of the holotype gave fairly accurate details of the juvenile color pattern, which is largely plain brown on body with indistinct spots on white fins and distinct dark spots on head. The lateral line is whitish.

Myers and Wade (1949, *Allan Hancock Pacific Exped. 9(4):82, pl. 14.*) described as new *Letharchus opercularis* from six specimens 190 to 381 mm., collected in Gardner Bay, Hood Island, Galapagos. Fowler (1932, *Proc. U. S. Nat. Mus. Vol. 80 (6):3,* and 1938, *Acad. Nat. Sci. Phila. Monog. (2):251.*) reported *L. pacificus* from Gardner Bay, Hood Island, Galapagos. He based his identification on three specimens, two of which are USNM 89730, and are now 207 and 292 mm. in length. These were collected June 30, 1929, by the Gifford Pinchot Expedition.

The description and figure of *Letharchus opercularis* Myers and Wade fit closely the two large specimens collected in 1956 by the second author. From an examination of the five specimens of *Letharchus pacificus* available we find a gradual change in color pattern from the holotype, USNM 87540 (which is the smallest specimen of this species known to us), to that of the adult color pattern (Fig. 1–2). We conclude, therefore, that *L. opercularis* is a synonym of *L. pacificus*.

Four specimens of *Letharchus pacificus* were carefully measured and these data, expressed in thousandths of length from snout tip to anus, are recorded in Table 1. The total length was not used in Table 1, because of the possibilities of loss of some of the tail and later regeneration causing the post-anal length of the body to be

shorter than in normal undamaged specimens. However, we are unable to detect any damage in the 4 specimens.

The distinctive features of *L. pacificus* are: dorsal origin a little behind a vertical line through rear of rictus; pectoral fin absent; anal fin absent except for a rudiment just in front of tip of tail; two opercular flaps, the anterior one smaller, a pocket formed between them; isthmus with a transverse groove; belly flat, with dermal folds lengthwise along the edge where the sides meet the flattish belly, these gradually disappearing posteriorly near anus; dorsal fin well developed, except becoming a fleshy ridge posteriorly on tail; anterior nostrils tubular, the edge of the distal opening with three or four short papillae, a groove around bases of tubular nostrils, and a fleshy isthmus between them, its posterior edge Y-shaped; posterior nasal opening in edge of lip below eye; eye small, located a little closer to rictus than snout tip; small conical teeth in a single row on both jaws, and a patch of similar teeth on the vomer; mid-dorsal line of head formed by a fleshy ridge; lateral line prominent extending from head to tip of tail, with 89 and 97 pores to opposite anus and a total of 152 and 162 pores, respectively.

The characteristic color pattern of both specimens collected by the second author is well represented by that of the 564 mm. specimen, MCZ 40432, in Fig. 1 and 2, based on drawings by Dorothea B. Schultz.—Leonard P. Schultz and Otis Barton, *Division of Fishes, U. S. National Museum, Washington 25, D. C.*

ADDITIONAL RECORDS OF THE CARANGID FISH *URASPIS HEIDI* FOWLER.—The carangid fish *Uraspis heidi* Fowler (1938, *Proc. Acad. Nat. Sci. Phila. 90:149–51.*) was described from a single specimen from off Manasquan, New Jersey. Ginsburg (1952, *Publ. Inst. Mar. Sci. 2(2): 43–117.*) described a second specimen taken by the "Oregon" in 32 fathoms off the Mississippi Delta. A third known specimen, from off North Carolina, was reported by Berry (1959, *Fish. Bull. U. S. Fish. & Wildl. Serv. 59:417–535*).

Two additional specimens have been taken off Cape Hatteras, North Carolina, in the fall of 1958: (1) 10/31/58, 2 miles S.W. of Diamond Shoals Lightship, in 25 fathoms; (2) 11/7/58, 4 miles S.W. of Diamond Shoals Lightship, in 25–30 fathoms. These specimens were collected by the crew of the Hatteras trawler "Mitzi Kay" in the course of normal winter trawl fishing operations off the North Carolina coast (as described by Pearson, 1932, *U. S. Bur. Fish. Invest. Rept. 10:1–31*).

In Table 1, characteristics of these specimens are compared with those previously reported. Comparison of these characters affords a better insight into the degree of variation within this species.

The variation in anal fin ray count is somewhat misleading, for the anterior anal spines are more or less obscured by skin, the degree of exposure being indicated by the tabulated figures.

Apparently, there is a latitudinal difference in the number of scutes in this species, with the North Carolina specimens being intermediate. Although both of our specimens have a total of 36 scutes on both sides, there is some difference in the degree of development of the more anterior scutes: one specimen (10/31/58) has no crests on the anterior two scutes on the right side, while the other (11/7/58) has no crests on the anterior three scutes of either side.

These two specimens of *U. heidi* are to be deposited in the U. S. National Museum.

These specimens were obtained and studied during the course of research supported by a grant (G-5838) from the National Science Foundation to Dr. I. E. Gray of Duke University and aided by the Cape Hatteras National Seashore of the National Park Service. The author wishes to express his appreciation to Dr. I. E. Gray, and to Mr. Donald Oden and the crew of the "Mitzi Kay" for their interest and cooperation.—Harry W. Wells, *Zoology Department, Duke University, Durham, North Carolina.*

Table 1. Characters of Known Specimens of *Uraspis heidi*

Locality	N.J.	La.	N.C.	N.C. 10/31/58	N.C. 11/7/58
Reference	Fowler, 1938	Ginsburg, 1952	Berry, 1959		
Standard length	273 mm	—	192 mm	243 mm	242 mm
Total length	320 mm	207 mm	238 mm	281 mm	281 mm
Dorsal	VIII, I, 28, i	VIII, I-29	VIII, I-29	VIII, I-28	VIII, I-29
Anal	II-I, 22, i	O, I-22[1]	I, I-22[2]	II, I-22	O, I-22[1]
Pectoral	II, 21	23	I-22	I-22	I-22
Ventral	I, 5	—	—	I-5	I-5
Gill rakers	6 + 15	6 + 14	6 + 14	7 + 15	6 + 14
Scutes	34	38	36	36	36

[1] two spines covered by skin
[2] one spine covered by skin

ON THE POSSIBLE ASSOCIATION BETWEEN AN ARCHIBENTHIC FISH AND A TUNICATE.—The offshore iniomous fish *Chlorophthalmus agassizi* has been found to be one of the commonest species at depths between 100 and 400 fathoms, and in certain trawl hauls completed by the U. S. Fish and Wildlife Service vessels *Oregon* and *Silver Bay* this species frequently numbers in the hundreds. Since little is known of the habits of this species, the association noted at one such station is reported here.

Silver Bay station 486 was a shrimp trawl haul completed at a depth of 180 to 200 fathoms off the east coast of Florida (29°56'N., 80°11'W.; June 20, 1958). In the catch were many *Chlorophthalmus agassizi*, some of especial interest since they were found *inside* of the benthonic tunicate, *Amaroucium* sp. A natural relationship between these two animals, indicative of inquilinism, is strongly suggested, but its nature remains to be determined. It is not likely that the presence of the fish in the tunicate is associated with reproduction or parental care, for although the eggs and larvae are not known from Western Atlantic waters, those of the Eastern Atlantic counterpart are pelagic (Sanzo, 1915, *Mem. Com. Talassogr. Ital. 49:14*; Tåning, 1918, *Rept. Danish Oceanog. Exp. . . . 2(5; A.7):5*). It is possible that the fish serves some purpose such as the "parasite cleaning" phenomena currently under study in several tropical areas, or that *Chlorophthalmus* uses *Amaroucium* as a refuge when under the attack of a predator, in this case a shrimp trawl.—WARREN F. RATHJEN, *United States Fish and Wildlife Service, Gloucester, Mass.*

THE AMERICAN CYPRINID FISH *NOTROPIS KANAWHA* IDENTIFIED AS AN INTERSPECIFIC HYBRID.—*Notropis kanawha* Jordan and Jenkins (in Jordan, 1888, *Proc. U. S. Nat. Mus. 11:354–55, pl. 44, fig. 5*) was described from specimens collected in Reed Creek, a tributary to the New (upper Kanawha) River, near Wytheville, Virginia. Although it was said to be rather common, repeated fish collecting in the area has failed to uncover it since, and later references to the species are compiled. The original characterization and subsequent examination of the type material suggest a distinctive fish, and *N. kanawha* is commonly cited, together with *Notropis scabriceps* (Cope), *Phenacobius teretulus* Cope, *Etheostoma osburni* (Hubbs and Trautman), and *Etheostoma kanawhae* (Raney), as an endemic species of the upper Kanawha system. The lack of additional material of *Notropis kanawha* has stimulated restudy of the type specimens in an effort to determine the systematic status of this species.

Several rare nominal American fishes have been shown to be based on hybrids (e.g., Hubbs, 1920, *Aquatic Life 5* [*9*]:*101–3*; Raney, 1940, *Copeia* [*4*]:*270–1*; Hubbs and Bailey, 1952, *Pap. Mich. Acad. Sci., Arts, and Letters 37* [*1951*]: *143–52*; Hubbs, 1955, *Syst. Zool. 4* [*1*]:*1–20*; and included references). This circumstance, in association with the observed rarity of *Notropis kanawha*, creates the suspicion that *kanawha* is an interspecific hybrid.

Examination of four of the original type series (USNM 39928) shows close agreement with the original description. The pharyngeal arches had been removed from only one specimen, in which the tooth count is 4–4, as described for the species. Two other specimens have the same count, and the fourth individual has 1,4–4,0. The presence of a second row of teeth in American cyprinids which typically have one row is uncommon, adding credence to the interpretation that *kanawha* is a hybrid, one parent of which has two rows of teeth.

Comparison of the National Museum syntypes of *Notropis kanawha* with the various cyprinid fishes known to occur in the upper Kanawha system, especially in Reed Creek, reveals that in most characters *Notropis kanawha* is intermediate between *Notropis rubellus* (Agassiz) and *Notropis volucellus* (Cope), both of which are common forms in the area. Two specimens in the collection of The University of Michigan Museum of Zoology are identified as hybrids between these species: UMMZ 111950, 49.5 mm., from Houghton Lake, T. 24 N., R. 3 W., sec. 33, Roscommon County, Michigan, and UMMZ 118854, 41.5 mm., from Second Creek, at mill 5 miles from mouth, Greenbrier-Monroe county line, Greenbrier River drainage of the upper Kanawha River system, West Virginia. These fish are indistinguishable in appearance from the National Museum syntypes of *kanawha*, and, significantly, both have the dental formula 4–4. Three additional syntypes of *Notropis kanawha*, 42 to 49 mm. long, are in the collection of the Stanford Natural History Museum (SU 624). They have been examined through the courtesy of Miss Margaret Storey, and all prove to be *Notropis volucellus*. All have 8 anal rays, 12 rows of scales around the caudal peduncle, and 4–4 teeth; lateral-line scales number 35, 37, 37, and body-circumference scales are 20, 22, 22. All have greatly elevated lateral scales anteriorly. Proportions (expressed as thousandths of standard length) include: distance from dorsal origin to tip of snout 506, 495, 536; dorsal origin to caudal base 504, 531, 503; dorsal height 226, 227,

TABLE 1. COUNTS AND PROPORTIONAL MEASUREMENTS OF *Notropis rubellus*, *Notropis volucellus*, *Notropis "kanawha,"* AND OF TWO HYBRIDS, *Notropis rubellus* × *N. volucellus* (FOR SOURCE SEE TEXT)

Character	*Notropis rubellus* USNM 109480	Hybrids		*Notropis "kanawha"*				*Notropis volucellus* USNM 179885[2]
		UMMZ 111950	UMMZ 118854	USNM 39928	USNM 179894			
Anal rays	9–10 (9.9)	9	9	9	9	9	8	8–9 (8.2)
Predorsal scales	19–23 (21.0)	16	16	15	14	15	14	13–16 (14.1)
Lateral-line scales	38–41 (38.8)	38	39	38	38	38	37	33–36 (34.6)
Body-circumference scales	25–31 (27.6)	23	24	24	23	21	23	20–24 (22.0)
Caudal-peduncle scales	12–14 (13.7)	12	12	12	12	12	12	12 (12.0)
Pharyngeal teeth	2,4–4,2 (2,4–4,2)	4–4	4–4	1,4–4,0	4–4	4–4	4–4	4–4 (4–4)
Standard length (mm.)	45.5–56.5 (51.4)	49.5	41.5	58.0	51.0	57.5	50.0	36.0–47.5 (42.0)
Dorsal to snout	533–563 (552)	519	535	524	526	539	520	495–542 (518)
Dorsal to caudal base	442–488 (467)	485	501	491	480	473	504	490–525 (509)
Dorsal origin to lateral line	120–133 (126)	115	128	133	137	139	138	136–153 (146)
Caudal-peduncle depth	82–95 (88)	91	94	95	98	96	104	95–111 (106)
Head length	235–256 (248)	242	258	241	255	252	250	247–267 (257)
Head depth	149–162 (156)	151	161	159	167	160	160	164–182 (173)
Orbit length	69–74 (72)	79	80	79	76	80	78	84–91 (88)
Mandible length	100–108 (105)	99	104	97	106	97	104	88–104 (97)
Exposed height, 5th lateral-line scale	36–44 (39)	46	48	56	53	52	56	60–73 (67)
Dorsal-fin height	187–220 (208)	202	224	217	231	216	232	234–255 (245)
Pelvic-fin length	126–159 (147)	154	164	152	171	157	164	160–183 (168)
Ratio: dorsal origin to snout/dorsal origin to caudal base	(1.13–1.25) 1.18	1.07	1.07	1.07	1.09	1.14	1.03	(0.96–1.09) 1.02

[1] Means for class groups are in parentheses. Measurements, expressed as thousandths of standard length, and tooth counts were taken on ten specimens each of *rubellus* and *volucellus* from Reed Creek, Wythe County, Virginia. Fin-ray and scale counts are from 25 specimens of each species.

[2] Fin-ray and scale counts include 7 specimens (USNM 179886) from the New River, 6 miles above Galax, Virginia.

228; and exposed height of fifth lateral-line scale 55, 57, and 61. In these and other characters they are typical of *Notropis volucellus*. Two non-type specimens from Reed Creek, Virginia, which apparently were collected at or about the same time as the types and are labeled as *Notropis kanawha* in the U. S. National Museum (nos. 40206 and 40329), are also identified as *Notropis volucellus*.

Counts and measurements of the National Museum syntypes (Table 1) indicate that these specimens are not identifiable as *Notropis rubellus* or as *N. volucellus*, but are variously intermediate between these species in most characters. The anal rays are usually 9 in *kanawha*, 8 in *volucellus*, and 10 in *rubellus*. The count of caudal-peduncle scales (12) is identical with that for *volucellus*, and counts of predorsal scales and body-circumference scales are closer to those for *volucellus* than for *rubellus*. The number of lateral-line scales, in contrast, more closely approaches that of *rubellus*. As noted above, the pharyngeal-tooth count is usually identical to that of *N. volucellus*, but we have never encountered a second row of teeth in that species, such as is present on one side in one syntype. The position of the dorsal fin, as indicated by proportional measurements from origin of dorsal fin to snout and origin of dorsal to caudal base and the ratio between them (Tables 1 and 2; Fig. 1), is close to the "midway" intermediacy between parent species that one usually en-

TABLE 2. RELATIVE INDEX VALUES FOR CHARACTERS OF HYBRIDS, *Notropis rubellus* × *Notropis volucellus*. DATA FROM TABLE 1

Character	Michigan UMMZ 111950 (1 specimen)	West Virginia UMMZ 118854 (1 specimen)	Virginia USNM 39928 and 179894 (mean of 4 specimens)
Anal rays	53	53	68
Predorsal scales	72	73	94
Lateral-line scales	19	−5	25
Body-circumference scales	82	64	87
Caudal-peduncle scales	100	100	100
Pharyngeal teeth	100	100	94
Dorsal origin to snout/dorsal origin to caudal base	69	69	63
Dorsal origin to lateral line	−55	10	50
Caudal-peduncle depth	17	33	56
Head length	−67	111	0
Head depth	−29	29	35
Orbit length	44	50	38
Mandible length	75	13	50
Height of fifth lateral-line scale	25	32	54
Dorsal-fin height	−16	43	41
Pelvic-fin length	33	81	76
Average of above characters	33	54	58

[1] For each character the mean for *rubellus* is assigned an index value of 0, that for *volucellus* a value of 100, and the value for the hybrids is computed. Thus, an index value of 50 means that the hybrid is exactly intermediate between the parent species in that character. Unfortunately, this method of analysis reduces all characters, weak or strong, to quantitative equivalence.

counters in the study of interspecific hybrid fishes. Other measurements that seem to approach this intermediate condition (Fig. 1) are dorsal origin to lateral line, caudal-peduncle depth, orbit length, mandible length, height of fifth lateral-line scale, dorsal-fin height, and pelvic length. Head length and head depth are not notably different from these measurements in *Notropis rubellus*.

The intermediacy in most characters (Table 2) furnishes compelling evidence for regarding these syntypes of *kanawha* as hybrids between *Notropis rubellus* and *N. volucellus*. The apparent close approach to one or the other parent species in a few characters likely indicates partial or complete dominance of one species in these features. If *kanawha* is a hybrid it should agree well with the two individuals from other localities determined as hybrids. The specimen from West Virginia is also from the upper Kanawha system, and is almost certainly identical taxonomically with *kanawha*, either as species or hybrid. The Michigan fish, however, may reasonably be interpreted as a hybrid, but it is most improbable that a rare species (*kanawha*) would occur only in central Michigan and in the upper Kanawha basin. As indicated in Tables 1 and 2, *kanawha* does agree closely with the two hybrids in all counts and in most of those measurements, such as caudal-peduncle depth, orbit length, mandible length, and exposed height of fifth lateral-line scale, that most sharply distinguish the species. The Michigan hybrid is notably slender and has a short head and a low dorsal—variations that are close to or within the observed limits for *rubellus*. Except for the slim body this fish bears strong similarity to the original figure of *kanawha*. We conclude that all six specimens are hybrids between *Notropis rubellus* and *N. volucellus*.

Notropis kanawha was described without designation of a holotype. Since the seven syntypes known to us include both hybrids and specimens of *volucellus*, it seems desirable to designate a lectotype and thereby to prevent possible confusion in nomenclature. The original figure and description were obviously drawn from hybrids rather than from *volucellus*. We therefore designate as lectotype of *Notropis kanawha* Jordan and Jenkins the syntype from USNM 39928 that is 58 mm. in standard length and has the pharyngeal tooth count 1,4–4,0 (see Table 1). This specimen retains the original number; the other syntypes, now paratypes, are entered as USNM 179894.

Notropis rubellus and *N. volucellus* display marked differences in habitat preference and time of spawning, and it is probable that these, rather than genetic incompatibility, are responsible for the rarity of hybridization. *N. rubellus* usually inhabits clear streams of moderate or steep gradient with a clean bottom of sandy gravel, gravel, or bedrock, over which it spawns in the current, chiefly in May (Trautman, 1957, *Ohio St. Univ. Press*). *N. volucellus* characteristically lives in clear lakes or sluggish, low-gradient streams with abundant vegetation and with a bottom of sandy silt, gravel or clayey silt (Trautman, *op. cit.*). The breeding habits of *volucellus* are imperfectly known, but ripe females have been taken from mid-May to late July (Black, 1945, *Invest. Ind. Lakes and Streams 2 [18]:450–69*). It may be presumed that hybridization between these species is accidental, involving fortuitous transfer of sperm between spawning groups. Stream situations where swift current over clean gravel and quiet backwaters with a silty bottom are closely approximated could provide the necessary habitat. Five of the six hybrids were collected in streams, and all six come from areas inhabited by both parent species. There is at least limited overlapping in spawning season, as evidenced by the fact that gravid females of *rubellus* and *volucellus* were taken in Reed Creek on July 17, 1938.

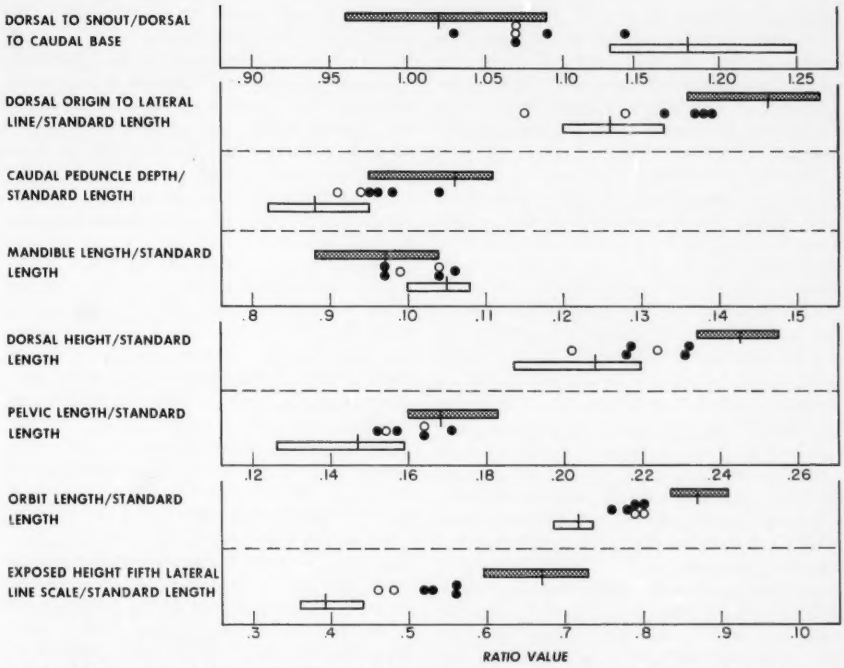
DORSAL TO SNOUT/DORSAL TO CAUDAL BASE
.90 .95 1.00 1.05 1.10 1.15 1.20 1.25
DORSAL ORIGIN TO LATERAL LINE/STANDARD LENGTH
CAUDAL PEDUNCLE DEPTH/ STANDARD LENGTH
MANDIBLE LENGTH/STANDARD LENGTH
.8 .9 .10 .11 .12 .13 .14 .15
DORSAL HEIGHT/STANDARD LENGTH
PELVIC LENGTH/STANDARD LENGTH
.12 .14 .16 .18 .20 .22 .24 .26
ORBIT LENGTH/STANDARD LENGTH
EXPOSED HEIGHT FIFTH LATERAL LINE SCALE/STANDARD LENGTH
.3 .4 .5 .6 .7 .8 .9 .10
RATIO VALUE

Fig. 1. Measurement ratios for selected characters of *Notropis rubellus* (open bars), *Notropis volucellus* (hatched bars), and hybrids between these species (circles). Mean values or *rubellus* and *volucellus* are indicated by vertical lines. Types of *Notropis "kanawha"* are shown as solid circles, other hybrids as open circles. Data from Table 1.

In summary, *Notropis kanawha* Jordan and Jenkins, long believed to be a rare cyprinid fish endemic to the upper Kanawha River system, is interpreted as an interspecific hybrid: *Notropis rubellus* × *N. volucellus*. A lectotype of this nominal species is designated. Four types of *kanawha* and two other hybrids have characters that are mostly intermediate between the parental species, but in a few characters the hybrids agree with or closely approach one parental form. The hybrid identification is based primarily on morphological evidence, but is consistent with the geographical distribution and ecology of the parent species. The hybrid combination is apparently rare and has not been reported previously.—Reeve M. Bailey, *Museum of Zoology, The University of Michigan, Ann Arbor, Michigan,* and Carter R. Gilbert, *United States National Museum, Washington, D. C.*

A RECORD OF THE GEMPYLID FISH *PROMETHICTHYS PROMETHUS* FROM OFF THE EAST COAST OF THE UNITED STATES.—During exploratory trawling operations by the Bureau of Commercial Fisheries research vessel *Delaware*, approximately 85 miles south of Martha's Vineyard, Massachusetts, a specimen of the species *Promethicthys promethus* (Cuvier and Vallenciennes) was taken. The fish was included in the catch of a number 36 whiting trawl which had been fishing on the bottom at a depth of 175 fathoms. The location of this trawl station (*Delaware* Cruise 60-1, phase II, Station 39, January 28, 1960) was 40°01′N. latitude, 70°50′W. longitude.

Measurements taken from the specimen after preservation include, total length, 347.0 mm.; standard length, 310.0 mm.; head length, 84.2 mm.; eye diameter, 19.5 mm.; and depth, 46.7 mm. The specimen has been placed in the fish collection of the Museum of Comparative Zoology, Cambridge, Massachusetts (MCZ No. 40598).

Previous occurrences of *P. promethus* in the Western North Atlantic off the United States have been recorded by Springer and Bullis (1956, *U. S. Fish and Wildl. Serv. Spec. Sci. Rept. Fish. 196*) who list three specimens from the Gulf of Mexico, two of which were taken in a dip-net while night lighting and the third was taken on long-line gear. All of these above mentioned captures were made at offshore locations where the

depth of the water is over 500 fathoms. Grey (1953, *Copeia (3):135–41*) lists the following locations for this species "... the Azores, the Canaries, Bermuda, St. Helena, and Ascencion Islands in the Atlantic; Hawaii, Japan, the Philippines, and various south sea Islands in the Pacific."

Therefore, the winter occurrence of this species in the waters adjacent to the continental shelf off the northeastern coast of the United States is of particular interest with regard to its known distribution in the Western North Atlantic.—WARREN F. RATHJEN, *U.S. Dept. of Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, Branch of Exploratory Fishing, Gloucester, Mass.*

THE NOMENCLATURE OF *CENTROPRISTIS*, CUVIER, 1829.—The serranid genus *Centropristis* is most commonly spelled *Centropristes* because it appeared in this latter form in Cuvier and Valenciennes (*Histoire Naturelle des Poissons, 3:37*, 1829). However, it seems clear that this genus was first proposed in another work which appeared earlier in the same year, this being the second edition of the *Règne Animal* (Cuvier, *2:145*, 1829). In this work the name ends with a *-tis*. Sherborn (*Ann. Mag. Nat. Hist., ser. 9, 15:600*, 1925) has stated that the third volume of Cuvier and Valenciennes appeared in April, 1829. Fowler (*Proc. Acad. Nat. Sci. Philadelphia, 59:264*, 1907) gives evidence that the fish volume (the second) along with volumes one, four, and five of the *Règne Animal* appeared earlier in the year since they were reviewed in the *Foreign Quarterly Review* for the period January-March, 1829. Jordan (*The Genera of Fishes, p. 126*, 1917) helped perpetuate this error by accrediting the same spelling (*Centropristes*) to both the *Règne Animal* and the *Historie Naturelle des Poissons*.—JOHN C. BRIGGS, *Institute of Fisheries, University of British Columbia, Vancouver 8, Canada.*

CLINOSTOMUS FUNDULOIDES GIRARD TO REPLACE *CLINOSTOMUS VANDOISULUS* (VALENCIENNES) AS THE NAME OF THE ROSYSIDE DACE OF EASTERN NORTH AMERICA.—In the completion of "A taxonomic study of the cyprinid fish *Clinostomus vandoisulus* (Valenciennes) in the eastern United States" (Deubler, *Doctoral Dissertation, Cornell University*, 1955), it became apparent that the original description (Valenciennes *in:* Cuvier and Valenciennes, *Histoire naturelle des poissons, 17:317–318*, 1844) contained certain erroneous data. The dorsal fin ray count (10), the anal fin ray count (11), and the body length (7 inches) given by Valenciennes did not fall within the range of data resulting from the intensive study which embraced nearly 2,000 specimens of the rosyside dace. It was therefore necessary to re-examine the type material and this was done when the senior author visited the Muséum National d'Histoire Naturelle, Paris, France during June, 1956 while on a John Simon Guggenheim Fellowship.

The original material of *Leuciscus vandoisulus* Valenciennes consists of two syntypes (*Mus. Nat. Hist. Nat. No.* 1686) recorded as taken by M. Bosc in the "Carolines," U.S.A. They measure 145 mm. and 160 mm. in standard length. Study of these specimens revealed that they represent a form of the Eurasian genus *Leuciscus* and not a species present in the American fauna. Nomenclatorily we thus have two choices: 1. appeal to the International Commission of Zoological Nomenclature for retention of the name *vandoisulus*, or 2. use the first available name to represent the common American form, the rosyside dace. While our general philosophy favors the retention of a specific name which has remained in the literature for many years and which has been widely used, we cannot reject the information available to us from good type material. There is no evidence that these two types do not represent the original specimens. We therefore place *L. vandoisulus* Valenciennes in the synonymy of the Eurasian genus *Leuciscus* and probably specifically in *L. cephalus* (Linnaeus) (*Systema Naturae, ed. 10, p. 322*, 1758, type locality southern Europe). It is unusual that Valenciennes did not recognize a common European species, and especially so when he mentioned that the dorsal and anal fins were similar to those of *Leuciscus vulgaris* (*op. cit., p. 318*, 1844). These fins, in the syntypes, are quite like those of *L. vulgaris*, a European cyprinid, and unlike those of the American rosyside dace. Just how Bosc's name and field data became attached to this jar of fishes may never be known.

The following description, based on the two syntypes of *L. vandoisulus*, is sufficient evidence to relegate this nominal species to the above named synonymy. The methods of counting and measuring follow those given by Hubbs and Lagler (*Fishes of the Great Lakes Region, Cranbrook Institute of Science, Bull. 26*, 1957). Counts are first listed for the smaller syntype and are followed by those for the larger specimen: dorsal fin rays 9 and 9; anal fin rays 10 and 9; pectoral fin rays 18 and 17; scale rows along the lateral

line counting from the upper edge of the gill opening to the base of the hypural 45 and 44; scale rows above the lateral line 8 and 8; scale rows below the lateral line 4 and 4; circumferential scale rows counting from a point immediately in advance of dorsal fin 28 and 28; predorsal scales 23 and about 20; pharyngeal teeth 2, 5 on left side of smaller specimen, the right side missing and 2,5–5,2 on larger specimen; total number of gill rakers on first right arch 11 and 12. The following measurements are recorded in thousandths of the standard length: head length 266,275; diameter of eye 59,63; length of snout 69,71; length of upper jaw 88,92. Lateral line complete, curving downward from upper edge of the gill opening and reaching its lowest point about 7 or 8 rows of scales from the head; origin of dorsal fin about two to three rows of scales posterior to base of pelvic fins; outer margin of dorsal fin nearly straight; that of anal fin somewhat convex; caudal fin moderately forked.

The cycloid scale has characteristic radii on the anterior and posterior fields. Scales from the mid-side of the body above the lateral line have about 6 to 12 primary radii and 3 to 6 secondary radii on the posterior field; the anterior field has about the same average number or slightly more but scales on the anterior part of body have fewer radii in the anterior field than the posterior.

The body was of a uniform pale coloration; snout moderately rounded; head short; mouth nearly terminal; length of upper jaw reaching vertical passing through anterior margin of eye, or nearly so; greatest body depth about 3.8 in standard length.

In contrast to some of these data, the American rosyside dace has a pharyngeal tooth count almost always (about 90 per cent) of 2,5–4,2 (54 specimens), and other combinations such as: 1,5–4,2(2); 1,5–4,3(1); 2,5–4,1(1); 2,5–4,3(1); 3,5–4,2(1); and 2,5,3–4,2(1) (Deubler, *ibid.*). A count of 5–5 in the main row of the rosyside dace has been recorded in the literature. It is either a rare occurrence or an error. The radii on the scales are only on the posterior field. This is characteristic of most native North American cyprinids. The largest rosyside dace examined in about 2,000 specimens sampled throughout its range was 93 mm. in standard length (3.7 inches), considerably smaller than the type material of *L. vandoisulus* (5.7 and 6.3 inches). The average number of dorsal and anal fin rays is less in the rosyside dace, the dorsal rays range from 7 to 9, usually 8 and the anal rays number 7 to 10, usually 9. The shape of the body and fins as well as the general body coloration in preserved specimens of the rosyside dace are unlike the type material. In the typical form of the rosyside dace the snout is sharp and pointed, the jaws are long and oblique; the caudal fin is sharply forked; sides of body with pale to dark, scattered spots or mottling; a prominent, dark lateral band on body, sometimes more pronounced on the caudal peduncle.

The first available name actually applying to the rosyside dace is one of three, all described by Girard in the same paper and on the same page [*Proc. Acad. Nat. Sci. Philadelphia, 8(1856):212,* 1857] namely, and in the order of occurrence on the page:

1. *Clinostomus funduloides,* type locality, Potomac River, Washington, D. C.; type USNM catalogue entry No. 6, consisting of one set of pharyngeal teeth with the formula 2,5–4,2. There were 10 or more specimens in the original collection of S. F. Baird, none of which is apparently extant.

2. *Clinostomus affinis,* type locality, James River, Virginia, type, USNM catalogue entry No. 5, consisting of one set of pharyngeal teeth with the formula 2,5–4,2. There were more than 20 specimens in the original series, collected by S. F. Baird sometime before December 1, 1856, none of which can be located today.

3. *Clinostomus carolinus,* type locality, Salem, North Carolina; type material catalogued under USNM No. 26; original lot contained 20 specimens, collected by J. T. Lineback and School, none of which is apparently extant.

Our basis for the selection of *C. funduloides* Girard as the name of the rosyside dace to replace *C. vandoisulus* follows: 1. Girard's description compares *C. funduloides* with a well known, closely related species, *C. elongatus;* 2. his description of body proportions, coloration and size, although incomplete, applies best to the rosyside dace; 3. the type material consisting of pharyngeal arches with a formula of 2,5–4,2, eliminates from consideration a number of cyprinids; and 4. it is the first and best description given by Girard of the three names under question.

We wish to thank the following individuals for diligently searching their records and collections for information or specimens of Girard's types mentioned above: James E. Böhlke, The Academy of Natural Sciences, Philadelphia, Pa.; Myvanwy M. Dick, Museum of Comparative Zoology, Cambridge, Mass.; W. I. Follett, California Academy of Sciences, San Francisco, Calif., and Pearl Sonoda, Chicago Natural History Museum, Chicago, Illinois. Our appreciation is also extended to J. Guibe, Muséum National

d'Histoire Naturelle, for his assistance while the senior author was studying at Paris.—ERNEST A. LACHNER, *U. S. National Museum, Washington, D. C.*, AND EARL E. DEUBLER, JR., *Institute of Fisheries Research, University of North Carolina, Morehead City, N. C.*

Herpetological Notes

SEASONAL PHYSIOLOGICAL CHANGES IN THE RED-EARED TURTLE, *PSEUDEMYS SCRIPTA ELEGANS*.—Recent studies on the effect of hibernation on blood chemistry in two species of turtles suggested that certain seasonal changes were innate (Hutton and Goodnight, 1957, *Physiol. Zool. 30:198–207*). Other studies have suggested inherent cyclic changes in turtles (Riddle, 1909, *Am. J. Physiol. 24:447–458*; Fetter, Combs and Pike, 1942, *Anat. Rec. 84:532*; Claire, 1956, *Biol. Bull. 111:190–203*). The present study investigated the existence of endogenous physiological cycles in packed cell volume and blood glucose, amino-acid nitrogen, and lipoid-phosphorus levels in the red-eared turtle, *Pseudemys scripta elegans*.

Monthly determinations of these blood characteristics were made for one year in two groups of animals: a control group kept under conditions similar to those normal for the animal; the other, the experimental group, maintained under conditions artifically kept constant. All animals were fed whitefish and lettuce at weekly intervals, although none were fed for one week previous to chemical examination.

All animals were collected in the region of Schriever, Louisiana. The control group of 120 turtles was kept in large outdoor concrete pits approximately three to four feet in depth on the campus of Tulane University in New Orleans, about 60 miles from Schriever. Basking platforms were available for the animals' use. The experimental group of 50 animals was kept in large washtubs elevated at one end, the lower end containing water. These were in a constant temperature room at 20°C and received twelve hours of light per day from an incandescent bulb. During the lighted period they also received two hours of irradiation from a sunlamp. The turtles had been removed from conditions similar to those of the controls and under these experimental conditions for one month when the first blood analyses were done upon the animals in July, 1957. Ten control animals were analysed concurrently with each monthly group of ten experimental animals.

Two smaller short term groups of ten animals each, which had been under conditions similar to the controls, were maintained under experimental conditions for four weeks in December and the first two weeks in January. Their blood was examined at the end of this period. One group was kept at 27°C (summer temperature) and ten hours of light daily (winter light). The other short term group was exposed to normal outdoor winter temperatures (mean approximately 12°C) and fourteen hours of light daily (summer light).

Blood was obtained by cardiac puncture with a #22 needle after a hole had been drilled through the plastron with a 3/16 inch bit. Approximately 0.6 ml of blood was withdrawn, and potassium oxalate was used as an anticoagulant. After bleeding, the hole in the plastron was plugged with a cork and the animal returned to its group. Because of the size of the group and occasional mortalities, after the first four months of the study it was necessary to rebleed the experimental group, although in no case was an individual turtle bled on two successive months. Each turtle in the control group was bled only once.

Packed cell volumes were obtained using the method of Van Allen (1925, *J. Am. Med. Assn. 84:202–203*). Uric acid was determined according to the method of Folin (1934, *J. Biol. Chem. 106: 311–314*). Other biochemical determinations followed the techniques as put forth in the *Manual of Standardized Procedures for Spectrophotometric Chemistry*, edited by Fister (Standard Scientific Supply Corp., N.Y., 1950).

Before discussing the results of biochemical studies, a few comments regarding feeding habits and general behavior are in order. The control animals showed a definite decrease in consumption of food during the months of November, December, and January. Much unconsumed food had to be removed from the bottom of the pits after feedings during this period. This decrease cannot be ascribed solely to lower water and body temperature since a similar pattern was displayed by the experimental animals kept at 20°C and 12 hours of light. On the other hand, the short term animals kept at 27°C maintained a high food consumption. An innate seasonal change in metabolism is evident, but one which

TABLE 1. BLOOD ANALYSES OF PIT AND LABORATORY ANIMALS

Month	Pit Water Temp. °C	Lipoid Phosphorus mg%		Amino-acid, Nitrogen mg%		Glucose mg%		Packed Cell Volume %	
		Pits	Lab	Pits	Lab	Pits	Lab	Pits	Lab
July	28	10.6 ± 0.8	12.3 ± 1.1	19.4 ± 0.9	16.6 ± 0.5	77 ± 6	61 ± 6	20.4 ± 0.8	20.3 ± 0.8
Aug.	26	9.0 ± 0.9	9.9 ± 0.4	17.7 ± 1.1	23.5 ± 0.9	67 ± 3	73 ± 6	19.0 ± 0.9	17.4 ± 0.8
Sept.	24	9.9 ± 0.6	7.0 ± 0.6	18.1 ± 0.9	16.9 ± 1.0	60 ± 4	48 ± 5	18.0 ± 1.4	16.2 ± 1.4
Oct.	20	10.6 ± 0.6	8.1 ± 0.6	18.2 ± 1.2	10.5 ± 0.9	74 ± 5	55 ± 8	18.5 ± 1.2	17.9 ± 1.1
Nov.	14	9.3 ± 0.6	10.9 ± 1.0	10.2 ± 0.3	17.6 ± 0.7	75 ± 7	81 ± 11	18.9 ± 1.1	16.6 ± 0.8
Dec.	15	8.6 ± 1.3	10.7 ± 1.0	19.1 ± 1.0	17.5 ± 0.9	54 ± 5	67 ± 11	17.3 ± 1.0	16.7 ± 0.9
Jan.	11	9.5 ± 0.7	10.8 ± 0.9	14.5 ± 0.8	14.0 ± 0.5	60 ± 5	50 ± 6	19.6 ± 1.4	16.7 ± 0.7
Feb.	14	16.9 ± 0.8	14.2 ± 0.6	18.5 ± 1.1	21.8 ± 1.5	62 ± 7	83 ± 9	17.3 ± 1.2	17.4 ± 1.2
Mar.	16	13.0 ± 0.5	14.2 ± 0.7	25.2 ± 0.7	24.4 ± 1.7	85 ± 12	71 ± 9	18.9 ± 1.1	17.6 ± 1.2
Apr.	18	14.1 ± 0.6	14.8 ± 0.7	25.4 ± 2.3	26.1 ± 1.7	78 ± 7	75 ± 6	17.8 ± 0.9	18.1 ± 0.7
May	24	16.2 ± 0.6	14.8 ± 0.5	27.8 ± 1.8	24.1 ± 1.6	80 ± 5	68 ± 8	22.0 ± 0.6	17.3 ± 0.9
June	26	13.8 ± 0.4	12.6 ± 0.9	14.7 ± 0.6	21.8 ± 1.9	71 ± 9	83 ± 13	20.1 ± 1.1	16.8 ± 1.5
Mean	19.7	11.8	11.7	19.1	19.6	70	68	19.0	17.4

may be at least partially overcome by abnormally high temperature conditions.

During the months of March and April the turtles of both large groups were very active and excitable. Instead of being relatively docile, as in their normal behavior, many individuals were hostile or even aggressive. That this should occur in animals isolated from natural conditions is, again, suggestive of endogenous cyclic changes. This period of excitability is coincident with the mating period of these animals (Carr, 1952, *Handbook of Turtles, Cornell Univ. Press*).

Table 1 summarizes the results of the monthly chemical determinations and lists the water temperature in the pits at the time of analysis of the control group. Each monthly mean is followed by its standard error. Lipoid phosphorus appears to follow a seasonal pattern in both groups of animals. It is present in highest concentration in spring, is lowest in late autumn, and is independent of sex. In February, for example, lipoid phosphorus averaged 16.5 mg% in 5 male controls and 17.4 in 5 female controls; among experimental animals it averaged 14.5 mg% in 4 males and 14.0 in 6 females. Amino acid nitrogen does not show a pattern as clearly, although values in both groups of animals are consistently higher in the spring than at other seasons. Cyclic changes are again suggested.

Blood glucose did not appear to follow a seasonal pattern, the overall averages being 70 mg% for control animals, 68 mg% for experimental animals. Exploratory studies have indicated that lower temperatures usually mean slightly lower concentrations of glucose in this species. Although a greater number of low mean values in both groups of animals occurred during the winter months than at other times of the year, no clear-cut pattern is indicated. Experience has shown that glucose is variable in these animals and can be significantly affected by the method of handling prior to bleeding. It is possible to state only that the present data do not indicate seasonal changes of blood glucose in these turtles. Gordon Balmer (personal communication) has also detected no changes in blood glucose in turtles he has examined at different times of the year.

TABLE 2. BLOOD ANALYSES OF SHORT TERM GROUPS

Group		Lipoid Phosphorus	Amino-Acid Nitrogen	Glucose	Packed-Cell Volume
Temp.	Light	mg%	mg%	mg%	%
27°C	10 hr.	14.2 ± 0.7	20.4 ± 1.1	56 ± 4	19.7 ± 1.1
Ambient	14 hr.	10.9 ± 0.5	16.7 ± 1.1	54 ± 5	15.0 ± 3.0

Table 2 summarizes the finding in the two short-term groups analyzed in January. The ones under winter light but summer temperature consistently display higher values for all components than the group under winter temperatures but summer light. This difference most probably indicates the higher metabolic rate and higher food intake of the heated animals.

Summary—Red-eared turtles, *Pseudemys scripta elegans*, were studied for a one year period while under normal fluctuating and under experimental, constant environmental conditions. Feeding in both groups decreased during the winter months and both displayed greater excitability during the spring months at a time coincident with the breeding season. Although packed cell volumes and blood glucose did not show any consistent seasonal variation, values of the blood's amino acid nitrogen and lipoid-phosphorus reached their lowest levels during the

winter months and were highest during the spring or early summer. An internally controlled seasonal cycle in metabolism, independent of all except gross changes in the environmental temperature, is indicated.

This work was conducted under grants from the National Institutes of Health and the Louisiana Heart Association.—KENNETH E. HUTTON, *Department of Biological Sciences, San Jose State College, San Jose, California.*

ADDITIONAL RECORDS OF STREAM SALAMANDERS IN NEW BRUNSWICK.—Recently published distribution maps that include New Brunswick lack records of the stream salamanders *Desmognathus f. fuscus* and *Eurycea b. bislineata* for the southeastern corner of that province (Logier and Toner, 1955, *Roy. Ontario Mus. Zool. Contrib. No. 41, p. 16 and 20*; Bleakney, 1958, *Nat. Mus. Canada Bull. 155, p. 81 and 85*; Conant, 1958, *Field Guide to Reptiles and Amphibians, Maps. 171 and 194*).

During the period June 4 to 9, 1958, the authors conducted field studies for the National Museum of Canada in an area east of the Saint John River and south of the Miramichi River and both species were collected.

Forty-eight specimens of *Eurycea b. bislineata* from 14 stations varied in snout to vent measurements from 31 to 50 mm. One larva, 28 mm., was also taken. All specimens were found under rocks at the margin of, or in, the shallows of streams. The species was present in virtually every stream habitat examined (Fig. 1).

Ten specimens of *Desmognathus f. fuscus* from three stations varied from 20 to 55 mm., snout to vent. Seven salamanders from Fundy National Park were under stones along small streams, usually at a point where the water dropped from a slightly higher level. One individual from the same locality was under a stone on a grassy border of a stream. Two specimens from Scoudouc were under a log and a large stone, respectively, at the edge of a mill site pond. A small stream drains the pond.

Nova Scotia is replete with springs, seepage banks, and rocky streams that provide apparently identical habitats to those utilized by both species

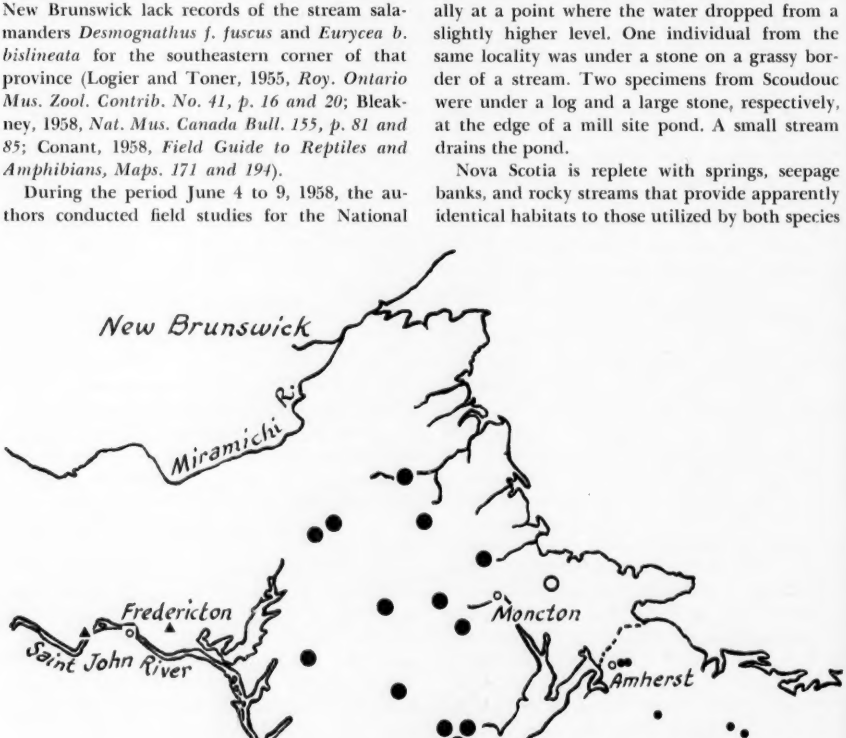

Fig. 1. Distribution records of *Eurycea b. bislineata* and *Desmognathus f. fuscus*. Small triangles represent previous locality records where both species were found. Solid large circles are new records for *Eurycea b. bislineata*; open large circles, new records for *Desmognathus f. fuscus*; large circles, half solid where both species found; small solid circles where both species sought but neither found.

in New Brunswick. However, no specimens have been reported from Nova Scotia and none were taken during the herpetological surveys of 1950, 1953, and 1955.

On June 9 and 10, 1958, diligent examination in and along suitable rocky streams in the Amherst-Oxford region, along the Wentworth Valley and at Truro yielded only an occasional red-backed salamander *Plethodon c. cinereus*. Weather and habitat were roughly the same as in New Brunswick during the previous five days.

Connecting Nova Scotia and New Brunswick is the Isthmus of Chignecto, consisting of the Bay of Fundy side of the extensive Tantramar salt marshes, and a low boggy landscape stretching from the marshes to the Northumberland Strait on the northeast. Streams in this area are, therefore, either saline or sluggish bog runoff. Bleakney (1958, op. cit. p. 42) postulated that this area might act as a barrier to the dispersal of the habitat-specific stream salamanders into Nova Scotia, but lacked adequate distribution data. Now that they are known to occur at the edge of the isthmus on the New Brunswick, but not the Nova Scotia side, the isthmus barrier concept is given further weight. Both species apparently are adapted to cool, oxygen-rich fresh water, and all streams of the isthmus lack one or more of these factors.—F. R. Cook and J. S. Bleakney, *National Museum of Canada, Ottawa, Ontario, and Perry Biological Laboratories, Acadia University, Wolfville, Nova Scotia.*

NEW LOCALITIES FOR THE PLAINS SPADEFOOT TOAD, TIGER SALAMANDER AND THE GREAT PLAINS TOAD IN THE CANADIAN PRAIRIES.—During the summer of 1959 the author made a preliminary survey of reptiles and amphibians of south and central Saskatchewan for the National Museum of Canada. Several new localities including range extensions were discovered during this survey and are herein reported.

Few records for the plains spadefoot toad (*Scaphiopus bombifrons*) in Saskatchewan have been published. Logier and Toner (1955, *Roy. Ontario Mus. Zool. Contrib. 41:1–88*) note only one locality, and Nero (1959, *The Blue Jay, 17(1): 41–42*) in summarizing all known data for the species in the province, lists only three additional stations.

Sixteen specimens of the species were collected from the following stations: (Fig. 1.) 1. Approximately 10 miles northwest of Main Centre: three individuals taken July 8, near the South Saskatchewan River. Two of these were taken on the flood plain of the river; and the third was found approximately 500 feet above the river at the

Fig. 1. Distribution records of *Scaphiopus bombifrons*. Open circles indicate previous records of the species; closed circles are records reported in this paper.

level of the surrounding prairie. 2. Swift Current: two specimens taken on July 8, calling sporatically from a partially flooded vacant lot in the town. 3. 3.7 miles west (on highway №1) of Swift Current: one toad collected on July 9, calling from a flooded field corner. This and the preceding specimens were the only ones heard calling during the summer. Perhaps the heavy rains at the end of June had stimulated breeding and these specimens were stragglers. 4. 2.2 miles west (on highway №1) of Webb (turnoff): one specimen collected July 9 in the water at the edge of a small rocky pond in a shallow gully. 5. 0.7–5.0 miles north (on highway №21) of Maple Creek: four live specimens collected and two dead ones identified on the pavement during a heavy rain, the night and early morning of July 20 and 21. 6. 4.2 miles east (on highway №1) of the junction of highways №1 and №21. One dead individual identified the same night as above. 7. 7.3 miles northwest (on highway №39) of North Portal, and 4.5–2.2 miles southeast (on highway №39) of Roche Percee: four live and three dead specimens collected or identified July 18.

The last collection represents the most easterly locality for the species in Saskatchewan. Although no records have been published for Manitoba, the National Museum of Canada has three specimens collected by C. M. Sternberg and labelled Dauphin, Manitoba, July 25, 1935.

Two collections of the tiger salamander (*Ambystoma tigrinum*) larvae were taken June 22 (3 specimens) and June 25 (4 specimens) from a pond on the south side of Prince Albert. The pond, as nearly as could be ascertained by enquiry, is permanent. The larvae were common along its muddy banks and active during the day and at night. Adults are reported locally as seen after rains in the summer and early fall. It is impossible to assign the population to its correct subspecies from larval specimens, but the

locality is at the edge of the range of the gray tiger salamander (*A. t. diaboli*) as given by Conant (1958, *Field Guide to Reptiles and Amphibians, map no. 169*). In Logier and Toner (1955, *Roy. Ont. Mus. Zool. Contrib. No. 41:1–88*) Saskatoon is the most northly locality given for the species. However, there is a previously unreported specimen in the National Museum of Canada from Ponass Lake (approximately 120 miles west and slightly north of Saskatoon). The Prince Albert collection is approximately 60 miles due north of a point perpendicular to it at the latitude of Ponass Lake. Enquiries at Prince Albert National Park, about 20 miles due north and slightly west of Prince Albert, yielded no reports of the species. As Prince Albert is at the southern edge of the boreal forest zone of northern Canada, and the tiger salamander is a prairie species, this may be its approximate northern limit in central Saskatchewan.

Four specimens of the great plains toad (*Bufo cognatus*) were collected and two others positively identified in the early morning (1:30–3:30) of July 21 on paved highway #1 north of Maple Creek, during a heavy rain. Measuring east from the junction of highways #1 and 2, specimens were found 1 mile (1 dead on road), 3 miles (1 alive on road), 5.1 miles (1 dead on road), 5.7 miles (1 dead on road), 6.4 miles (1 alive on road) and 6.5 miles (1 dead on road). Although Schmidt (1953, A checklist of North American Amphibians and Reptiles) defines the range, in part, as the southern part of Saskatchewan, no actual specimens have been previously reported. The nearest locality in Alberta is Medicine Hat (Logier and Toner, 1955 *op. cit.*), 60 miles to the west. It has also been taken further north in Alberta at Empress (Moore, 1953, *Copeia (3):180–181*) near the Saskatchewan border.—FRANCIS R. COOK, *National Museum of Canada, Ottawa, Ontario.*

THE CLAY NESTS OF *HYLA PARDALIS* SPIX.—For some years, the author and her late collaborator, Mr. Joaquim Venancio, had reason to suspect that other Brazilian tree-frogs besides *Hyla faber* might build clay nests for spawning. At the turn of this year, *Hyla pardalis* Spix (Fig. 1) was discovered building such nests at Teresópolis, in the state of Rio de Janeiro, 800–900 m. above sea-level.

While collecting there in the remnants of the Agriões marsh, the author noticed several little cavities that looked like unfinished nests of *Hyla faber* but were smaller. Several species of *Hyla* and other frogs were calling in this pocket of marsh but, in a roadside ditch near by, only the voice of *Hyla pardalis* was heard. It was in this ditch that the nests were found.

On December 30, 1959, a couple of *H. pardalis* were caught in the ditch. They were both in the water, the male in front of the female. A poorly finished nest in the background must have been overlooked. As the female was full of eggs they were put into a square, metal, water container with water and some branches of plants. On the second night the female laid her eggs in this very inappropriate spawning site, partly on the leaves, partly in the water and few on the walls. Later the couple got away but some of the clutch was raised to a small tadpole stage.

On January 1, 1960, a male *Hyla pardalis* was seen calling in a shallow depression on the bank of the ditch, above the water. It was caught, identified, and released for further observation. A visit to this spot at dawn on January 2 showed a small oval cavity, with a slightly pushed-up wall, containing water. It was 22 × 16 cm. at the top and 2 cm. deep. That evening and the next, the male returned to the cavity and was photographed in it by Prof. Gualter A. Lutz (Fig. 2). On January 4, the author was obliged to miss the evening observation. Next morning a clutch of eggs was floating on the water of the little nest (Fig. 3).

More nests were found on January 5, 7, and 8. The most perfect one was 18 × 14 cm. inside, 24 × 18 outside, with a cavity 2 cm. deep and a raised wall 2 cm. high. The cavity was slightly funnel-shaped and the wall rough. The weather was dry until the 8th when a few showers fell. During the dry nights few frogs were heard in the marsh and no *Hyla pardalis* called in the ditch. After that a male was heard calling near

Fig. 1. *Hyla pardalis* Spix photographed on a white wall.

Fig. 2. A *Hyla pardalis* male in his clay nest.
Fig. 3. Spawn of *Hyla pardalis* laid in the nest (night of January 4–5).

each of three nests, not inside, but concealed in the vicinity.

From then on the nests were kept under hourly observation from dusk until late at night when the calling generally diminished. No new developments occurred until the end of our stay. On the last night, January 17, a new nest was discovered with a male frog in it. He was photographed at work, turning around and patting the walls with his hands. More frequent patrols resulted in finding a couple inside the nest between 9 and 10 p.m., despite the moonlight. The

first attempt to photograph them failed because as soon as the nest was illuminated for focussing they scrambled out. The male vanished into the vegetation overhanging the back of the ditch but the female took shelter under a sheet of newspaper which was lying in the water. The male returned later and was photographed sitting in the nest. It was only after 2 a.m. on January 18 that they both came back and a photograph was obtained before they climbed out again. Two hours later they had not returned and daw[illegible] was approaching. Daylight revealed that after the last attempt, they had spawned in a natural hollow against the bank, quite near their nest.

This ditch is one of many ditches found at the edges of roads in Teresópolis, carrying the water of very small brooks and the overflow from pipes issuing out of gardens. For a few nights, a *Hyla pardalis* sang in the mouth of a drain along our ditch.

In the upper part of the ditch, where the first occupied nest was seen, the water flows on the open surface, below the banks. A little lower it is relatively deep and overhung by plants. In this part no nests were found but a number of metamorphosing larvae and young were caught. After that there are two wider shallows. In one of them the first pair was caught before finding their nest. The last set of observations was made in the other. Just below them was a well-built nest that was not used during our stay. The lowest part of the ditch abuts on a paved sidewalk and the water disappears underground.

Altogether this ditch seems a very poor and exiguous habitat for a rather large tree-frog (females 60–65 mm.). It is short and shallow and the level of water varies greatly during intense sunshine or torrential rain. The little nest on the bank above the water appeared to be in danger of drying when last seen with some tadpoles left in it. Nevertheless, *Hyla pardalis* has colonized this biotope and other similar to it. Its coloration of greens and browns, including a very dark, mud-colored phase, causes it to blend so well with the surroundings that even when the males are calling it is very difficult to find them. The nests are less perfect and standardized than those of *Hyla faber*. Sometimes there is a perfect little pool, at others not much more than a rampart shutting off a convenient hollow. It is not known whether building nest has become an obligatory feature of the reproductive pattern.—BERTHA LUTZ, *Museu National, Rio de Janeiro, Brasil.*

MORPHOLOGICAL VARIATION IN A LITTER OF TIMBER RATTLESNAKES.—On August 17, 1957, we captured a pregnant dark phase timber rattlesnake, *Crotalus horridus horridus* Linnaeus, in Allegany State Park, on a ridge (approximately 2200 feet elevation) west of Brown's Hollow about two miles south of Elko, Cattaraugus County, New York. We kept the snake in the laboratory until it gave birth to 12 young. Since records of entire litters of this species are rare (Conant, 1938, *Amer. Midl. Nat. 20:1–200*; Trapido, 1939, *Copeia 4:230*; Edgren, 1948, *Copeia 2:132*), measurements and scale counts were recorded for both the mother and her young.

The young were born during the night of September 24. One was dead, still in the fetal membrane. Another was still in its membrane at 8:00 a.m. All others were free from the membranes at that time. There was no evidence of egg teeth. One large, yolky, infertile egg was deposited with the young.

Two young shed their skins prior to the third day. Seven others had shed prior to the seventh day, one shed on the ninth day, and the last shed on the eighteenth day. Placentae had dropped from most individuals by the third day.

The snakes were kept alive for one month, then killed (October 26). Measurements and weights were recorded prior to preservation. Ranges and means of body measurements are given in Table I, and of scale counts in Table II. With few exceptions scale counts, measurements and sex ratios fall within ranges previously stated (Edgren, *loc cit.*; Gloyd, 1940, *Chicago Acad. Sci., Spec. Publ. No. 4:1–270*; Klauber, 1936, *Occ. Papers San Diego Soc. Nat. Hist. No. 1:1–24*, and 1937, *ibid, No. 3:1–56*; Klauber, 1956, *Rattlesnakes, Univ. Calif. Press*). The sex ratio was 1:1. Sexual dimorphism was evident in length and weight (additional length of males could account for their slightly greater weight), tail length, position of umbilicus, and number of bands and dorsal blotches. Females had twice as many dorsal blotches as did males. Sexual differences were present in all ventral scale counts, but differences in other scale counts were not significant. Females, although shorter, had more ventral scales, the greater number occurring anterior to the umbilicus. Since females generally are shorter than males, the ventral scales are smaller than in males.

One scale character was noted to differ from previously recorded averages. Twelve of the 13 snakes, including the mother, had only two postocular scales. Gloyd (*loc. cit.*) stated that there are usually four (2–6) postoculars in *Crotalus h. horridus*.

We wish to thank Mr. John Wright, Elko, New York, for guiding us to the snake den and assist-

TABLE 1. SUMMARY OF BODY MEASUREMENTS AND MARKINGS OF A LITTER OF *Crotalus horridus horridus* BORN IN CAPTIVITY

Characteristics	Males (6)*		Females (6)		Adult (1)
	Range	Mean	Range	Mean	
Weight, gms.	14.7–17.6	16.2	12.3–15.0	14.1	568.5
Total length, mm.	296–230	311.8	289–301.5	295.6	1170.0
Tail length, mm. vent to rattle	23–25	24.6	18.5–20	19.6	62.0
Size of button, mm.					
length	5.6–6	6	5.5–6	5.8	11 rattles
width	5–5.6	5.2	5	5	
Size of head, mm.					
length	19.2–20.5	20	19–20	19.8	45
width	12.5–14.1	13	12–13.5	12.6	35
Distance from post. end of umbilicus to vent, mm.	21–24	22.2	17.5–24	19.6	—
Length of fangs, mm.					
right	2.9–3.8	3.4	2.6–3.6	3.1	7.5
left	2.8–3.5	3.1	2.8–3.6	3.1	7.8
No. blotches on sides (may be part of bands from dorsum)					
right	20–24	22	21–24	23	spotting no longer
left	20–23	22	21–24	23	visible
No. complete bands	14–20	16	9–16	13	—
No. dorsal blotches	1–5	3	4–9	6	—

* Individual dead at birth not included in weights and measurements.

TABLE 2. SUMMARY OF SCUTELLATION OF A LITTER OF *Crotalus horridus horridus* BORN IN CAPTIVITY

Characteristics	Males		Females		Adult
	Range	Mean	Range	Mean	
Dorsal scale row formula	25–27, 23–25, 19	25.6–23.7–19	25–27, 23–27, 19	25.5–23.5–19	25–23–19
No. ventral scales	162–164	162.7	165–169	167.3	168
Ventral scales ant. to umbilicus	143–145	144	144–152	147.8	149
Ventrals encompassed by umbilical scar	4–5	4.2	4–5	4.8	4
Ventrals posterior to umbilical scar	14–16	14.8	12–17	14.8	15
No. divided caudals (additional no. just post. to vent)	3^{+1}–8	4.3	3^{+1}–4^{+2}	3.6	2
No. subcaudals	23–24	23.6	17–20	19	20
No supralabials					
right	12–15	13.3	12–14	13.2	13
left	11–15	13.3	13–15	13.5	15
No. infralabials					
right	14–16	15.2	13–16	14.8	14
left	16–17	16.2	14–17	15.2	15
No. oculars					
right	2	2	2–3	2	2
left	2	2	2–3	2	2
No. postoculars					
right	2	2	2	2	2
left	2	2	2	2	2
No. loreals*					
right	3–4	3.7	2–4	3.3	3
left	3–4	3.2	3–4	3.3	3
No. suboculars					
right	3–4	3.5	3	3	—
left	3–4	3.5	3–4	3	—

* Includes one very small post-supraloreal scale.

ing in capturing the snake.—MARGARET M. STEWART, GARY E. LARSON, AND THOMAS H. MATTHEWS, *Biology Department, State University of N. Y., College of Education at Albany.*

A RECORD SIZE FOR *DRYMARCHON CORAIS MELANURUS*.—It is generally conceded that snakes of the genus *Drymarchon* are the largest members of the Colubridae in the

New World. Amaral (1929, *Mem. Inst. Butantan, 4:325*) recorded a female of *Drymarchon corais melanurus* from Colombia having a head-body length of 2410 mm. and a tail length of 405 mm., giving the specimen a total length of 2815 mm. Beebe (1946, *Zoologica, 31:27*) recorded a specimen of *Drymarchon corais corais* from Caripito, Venezuela, having a total length of 2540 mm. and a weight of eight pounds. Conant (1958, *A Field Guide to Reptiles and Amphibians*, p. 153) gave the maximum length of *Drymarchon corais couperi* as 103½ inches (= 2628 mm.).

On March 16, 1960, I collected a male of *Drymarchon corais melanurus* in dense rainforest approximately 15 kilometers northwest of Chinajá, Alta Verapaz, Guatemala. The specimen (KU 57001) has a head-body length of 2450 mm. and a total length of 2950 mm. (measurements taken before preservation). This specimen is 135 mm. longer than the female recorded by Amaral (*supra cit.*).

Insofar as I know, this is the largest recorded size for the genus and is the largest known specimen of a colubrid snake from the New World. In the Americas this size is approached by members of three unrelated genera. Dixon (1952, *Copeia, 3:193*) recorded a female *Pituophis melanoleucus sayi* from Brown County, Texas, having a total length of nine feet (= 2745 mm.); Beebe (1946, *Zoologica, 31:21*) recorded a specimen of *Chironius carinatus* from Kartabo, British Guiana, having a total length of 2850 mm. I collected a *Spilotes pullatus mexicanus* at Chinajá, Guatemala, having a total length of 2618 mm. In the Old World two related genera of colubrids attain greater lengths. Tweedie (1954, *Snakes of Malaya*, p. 43) stated that *Zaocys carinatus* attains a length of more than twelve feet (= 3660 mm.). This species is rivaled in size by *Ptyas mucosus*, of which Wall (1921, *Snakes of Ceylon, p. 183*) recorded an individual having a total length of 3583 mm.—WILLIAM E. DUELLMAN, *Museum of Natural History, University of Kansas, Lawrence.*

AN UNUSUALLY LARGE AGGREGATION OF *LEPTOTYPHLOPS*.—The blind snake *Leptotyphlops dulcis dissectus* (Cope) is a common member of prairie communities in the vicinity of Stillwater, Payne County, Oklahoma. However, its moisture requirements and burrowing habits make it difficult to collect during the dry months of the summer season. These snakes may be secured with regularity only in the spring when the earth under surface rocks is sufficiently moist to permit them to live at the surface level. Blind snakes are usually taken singly, but groups of two to five are occasionally found. There seems to be no record of larger aggregations such as the one discovered by the author on May 9, 1959 at the north edge of Stillwater. While making a collection of amphibians and reptiles, a sandstone slab, measuring approximately 12 by 14 by 2 inches, was lifted revealing a mass of blind snakes. The terrain at the collection site is hilly and the vegetation is typical of a tall grass prairie. The slab under which the snakes were found was resting on a bed of soft clay about four feet below the brow of a hill 20 feet high. As the snakes were uncovered, they appeared to be in a tangled mass about six inches in diameter. When the light struck them they dispersed with amazing speed and doubtless several escaped into nearby holes despite the efforts of the collector. A total of 13 specimens were secured.

The eight males and five females range from 125 to 226 mm. in total length and the anterior supralabials are divided in all specimens.

It is difficult to explain this aggregational behavior in *Leptotyphlops dulcis*. Undoubtedly the moisture conditions contributed to the surface location of the mass of snakes. Conditions were optimum for blind snake collecting during the second week of May, 1959, and three additional specimens were taken on May 10 and ten on May 15. None of these 13 specimens were entwined although two were found under a single rock on three occasions. Since the collecting of *Leptotyphlops dulcis* is restricted to a short period of each year, aggregation could be a regular activity of this species but usually performed when the snakes are not readily accessible to collectors.

It is possible that the blind snakes were drowned out of the deeper crevices and holes in the soil by the inundating rains that fell during the week preceding the captures.

Aggregations are associated with breeding behavior in some colubrid snakes and this may be the explanation for such behavior in *Leptotyphlops*. The natural history of blind snakes is so poorly known that additional evidence would be required to substantiate this hypothesis.

This is contribution number 315 from the Department of Zoology and the Research Foundation of Oklahoma State University.—CLARENCE J. MCCOY, JR. *Department of Zoology, Oklahoma State University, Stillwater, Oklahoma*

ON THE UNIQUE SOUND PRODUCTION OF THE SURINAM TOAD, *PIPA PIPA*.—The sound producing apparatus of the male Surinam toad, *Pipa pipa*, differs from that of all other frogs. It consists essentially of two bony arytenoid elements suspended within a bony laryngeal box that is formed from the cricoid and thyrohyal elements. The bronchi open into the posterior

end of the chamber and the glottis surmounts the anterior end. The structures have been described and illustrated by Grönberg (1894, *Zool. Jahrb., Anat. Abt., 7:629–46*) and by Ridewood (1898, *Jour. Linn. Soc., London, 26:53–128*). Grönberg postulated that a sound would be produced by the arytenoid elements striking the sides of the laryngeal chamber. Ridewood pointed out that this was contrary to the action of the controlling muscle. This large-bellied muscle, termed a dilator by Ridewood, originates at one side of the base of the chamber, covers the exterior side, and inserts by a single tendon upon an anterior process of the arytenoid bone that projects beyond the chamber (Fig. 1). The muscle acts to move the long free part of the bone medially within the chamber, and Ridewood believed that the contact of the two bones would produce the sharp metallic clicking noise that the male toad makes in the breeding season (Rabb and Snedigar, *Copeia, 1960 (1):40–44*).

Upon the recent death of a male Surinam toad I found that these suggestions as to the source of the breeding noise were incorrect. Although by the time it was reached the activating muscle had lost sharp responsiveness to electrical stimulation, the arytenoids could be moved while in place by pulling on the muscle, the anterior process, or the long free part of the bone. A dull clicking noise could be made by pulling the free posterior end to an extreme medial position and suddenly releasing it against the inside of the chamber, but neither noise nor action seemed normal. Again, the posterior ends of the two arytenoids could not be brought together sharply enough to produce a sound, and the action appeared beyond the normal range of movement. Further, the irregular surfaces of the bones with their exposed rich vascular supplies argue against such contacts being normal.

However, a sharp click, practically identical with the sound made by the living animal, was produced anteriorly in the chamber when an arytenoid bone was started mediad by any of the methods mentioned. Dissection and observation revealed that the noise was apparently made at the ventral contact joint of the two arytenoid bones (indicated by the arrow in Fig. 1). Each has a cartilage disc upon its articular process in this joint. Opening the joint by movement of one of the bones caused its disc to slip or pop anteriorly and simultaneously the clicking sound was heard. Since one element must be stationary in this arrangement, a series of clicks is probably made by alternate movements of the muscles of the two sides (unless there are right- and left-voiced Surinam toads).

The evolutionary development of this complex vocal apparatus in *Pipa* is possibly related to the hydrostatic function or to the unique cartilaginous structural make-up of the lungs (Marcus, 1927, *Morph. Jahrb., 58:100–121*). Either factor may have precluded the sort of air movement used by other frogs in vibrating their vocal cords.

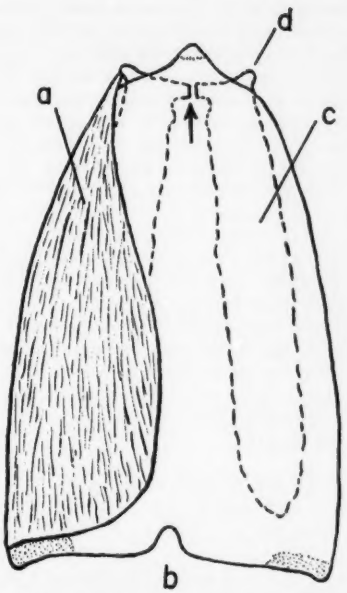

Fig 1. Vocal apparatus of *Pipa pipa*, ventral aspect. *a*, activating dilator muscle; *b*, bronchial opening area; *c*, arytenoid bone within the laryngeal chamber; *d*, anterior process of the arytenoid bone. Arrow indicates ventral contact joint of the arytenoid bones. Actual maximum width of chamber, 15 mm.

Thanks are given to Robert Snedigar and to the Tarpon Springs Zoo for the specimen.—GEORGE B. RABB, *Chicago Zoological Park, Brookfield, Illinois.*

AN ALBINO FIVE-LINED SKINK, *EUMECES FASCIATUS* LINNAEUS.—In the middle of August 1958 an albino five-lined skink, about three and one-half inches in total length, was collected at the Resthaven Wildlife Refuge, Erie County, Ohio. This specimen probably had hatched early that same summer. The base color of the body was pink and melanin was completely absent. The eyes were also pink. The five longitudinal stripes, though identical in position to those on normally pigmented individuals, were of a lighter color than the typical pale orange.

Two other young skinks, normal in color and of the same size, were collected at the same time and place, among the exposed roots of a tree situated at the crest of a four foot high bank sur-

rounding a pond. A normal adult five-lined skink was also seen in this area but not caught.

These three young skinks were kept in a terrarium and fed spiders, termites, etc. The albino specimen did not feed as well as the others and died after about three weeks. During this period it was much less active than the others and remained hidden whenever the terrarium was exposed to light. When purposely exposed to light, the albino skink's eyes were seldom open, in contrast to the normal individuals' eyes.

This specimen has been placed in The Ohio State Museum, OSM 1016 Reptiles. According to Hensley (1959, *Publications of the Museum—Michigan State University; Biological Series 1: 133–159*), this is the first known record of albinism in any North American lizard.—WILLIAM A. BRUNGS, JR., AND N. WILSON BRITT, *Department of Zoology, The Ohio State University, Columbus 10, Ohio.*

CALL DISCRIMINATION AND POTENTIAL REPRODUCTIVE ISOLATION IN *PSEUDACRIS TRISERIATA* FEMALES FROM OKLAHOMA.—Crenshaw and Blair (*Copeia 1959:215–222*) have reviewed the literature on the relationships of two members of the *Pseudacris nigrita* complex in the south-eastern United States, namely *feriarum* and *nigrita*. From their investigations of sympatric breeding populations of these forms they suggested that the distinct mating calls are important in the maintenance of reproductive isolation.

Another member of the *nigrita* complex is found in south-eastern Oklahoma and eastern Texas. It is referred to by Schwartz (1957, *Amer. Mus. Novit. 1838: 1–12*) as *P. triseriata triseriata* and, as the nomenclature indicates, is interpreted by him as representing a subspecifically related western population of *P. triseriata feriarum* (the *feriarum* of Crenshaw and Blair, *op. cit.*).

Littlejohn and Michaud (1959, *Tex. Jour. Sci. 11:86–92*), Littlejohn, Fouquette and Johnson (*Copeia 1960:47–49*) and Blair and Littlejohn (1960, *Evol. 14:82–87*) have shown how call discrimination experiments, using ripe hylid females, may be successfully employed in testing the operation of mating call differences as actual or potential premating isolating mechanisms.

During the spring of 1959 several gravid amplexed *triseriata* females were obtained at Wilburton, Oklahoma. This species, in southeastern Oklahoma and eastern Texas, has a mating call that may be described as a series of separate "clicks" and is somewhat similar to that of the *nigrita* of Crenshaw and Blair (*op. cit.*) in Georgia. The Oklahoma females were tested for discrimination against the calls of the other subspecies *P. triseriata feriarum*, which has a distinct call, and the different species *P. nigrita*, which has a rather similar call. The results of such tests might yield some indications of the level of potential reproductive isolation between the distant members of the complex. Only four females were tested but the definite nature of the results is such that they are considered worthy of reporting.

The apparatus used was the same as that described by Littlejohn and Michaud (*op. cit.*), namely an eight foot long tank with two small loud speakers, one at each end, connected to separate tape recorders. A switching mechanism was included so that the calls could be exchanged before the next trial began. Methods of testing discriminating ability also follow these authors. Any modifications are mentioned below.

Female *triseriata*, in amplexus when collected near Wilburton on April 15, were placed in an ice box and returned to the laboratory in Austin, Texas, two days later. Discrimination testing commenced about forty eight hours after collection. Tape recorded calls from the bioacoustical library at the University of Texas were selected at recording temperatures within 3.5°C. of the mean regulated laboratory temperature of 19.5°C. The calls were then transcribed on to fresh tape and made up into loops so that when played back the calls were repeated at a rate and loudness close to that of the original sound. These calls were also analysed on a Kay Sona-Graph Sound Spectrograph for the determination of physical characteristics (Table 1).

Frogs were placed in a mesh cage in the tank and allowed some thirty minutes to become

TABLE 1. PHYSICAL CHARACTERISTICS OF CALLS USED IN DISCRIMINATION TRIALS OF FEMALE *Pseudacris triseriata triseriata*

Species	Locality	Recording Temperature °C.		Duration (secs.)	Trill Rate (notes/sec.)	Dominant Frequency (c.p.s.)	Calls/minute
		Air	Water				
Pseudacris nigrita	Newton, Ga.	17	16	0.77	12	3450	22.6
Pseudacris triseriata triseriata	Wilburton, Okla.	20	19	0.76	18	3350	27.0
Pseudacris triseriata feriarum	Newton, Ga.	18	16	0.69	39	3000	33.3

settled, before testing was commenced. During this period the various calls which were later to be used in the trials were played over speakers in the tank.

In the initial experiment three females were tested in the tank at the same time with the calls of *triseriata* and *feriarum*. Four types of contacts with loud speakers were scored (see the footnote of Table 2 for explanation). Frogs were released at the center of the tank and after six contacts had been observed the calls were exchanged. Another nine contacts were then made by these females. All contacts were with the *triseriata* speaker, the *feriarum* speaker receiving no attention at all. The three frogs were comparably active.

Then the *feriarum* tape was replaced by a *nigrita* recording. Two trials were run using the calls of *nigrita* and *triseriata*. Twenty one contacts were made by the three females during two trials, eleven with the *triseriata* speaker and ten with the *nigrita* speaker.

On April 20 four different gravid females, (also from Wilburton) which had been refrigerated at 5.5°C. since returning to the laboratory, were placed in the tank for testing against the calls of *triseriata* and *feriarum*. Only one of these showed any reactivity at all, and during three trials made seven contacts with the *triseriata* speaker (one of Class 1 and 6 of Class 3), and one (Class 2) with the *feriarum* speaker. This latter transient contact occurred directly after the calls had been switched. The frog then moved on to contact the *triseriata* speaker within one minute of switching the calls. The results for the four reactive females are summarized on Table 2.

In the first set of trials the three female *triseriata* effectively discriminated between the call of a male of their own subspecies and that of a male *feriarum*, being attracted to the *triseriata* calls. Subsequently, however, these females did not effectively discriminate between the calls of *triseriata* and *nigrita*. In the trials involving the fourth active female, with the calls of *triseriata* and *feriarum*, only one misidentification occurred and this was transient in nature.

It is suggested that, in the populations tested, potential reproductive isolation by call is high between *triseriata* females and *feriarum* males but absent between *triseriata* females and *nigrita* males.

If Schwartz's (*op. cit.*) interpretation of the conspecific relationships between *triseriata* and *feriarum* is correct, then the distinct call of the overlap *feriarum* (Crenshaw and Blair, *op. cit.*) may be indicative of reinforcement processes (Blair, 1955, *Evol. 9:469–480*) during which the call of overlap *triseriata* has become considerably modified through selection for distinctness (particularly in trill rate) and ensuing reproductive efficiency. Conversely, distant allopatric *nigrita* and *triseriata*, while exhibiting some differences in call structure, have not diverged far enough to permit effective call discrimination by the remote *triseriata* females. Thus there appears to be effective potential premating reproductive isolation between allopatric populations of one species, while it is absent between disjunct allopatric populations of two different species.

TABLE 2. SUMMARY OF CONTACTS MADE WITH LOUDSPEAKERS BY *Pseudacris triseriata triseriata* FEMALES FROM WILBURTON, OKLAHOMA*

Loudspeaker Call	Class of Contact†				
	1	2	3	4	Total
P. t. triseriata	2	0	12	8	22
P. t. feriarum	0	1	0	0	1
P. t. triseriata	1	1	3	6	11
P. nigrita	0	0	4	6	10

* Data in upper section from 4 females; those in lower section from 3.

† 1. circled the speaker at a distance of 4–6 inches. 2. jumped at the speaker, making a transient contact with it, then passing on for about 6–10 inches. 3. sat about 2 inches away from the speaker. 4. made deliberate contact with the speaker by jumping or climbing over it or sitting on or against it.

This work was carried out while the author was in receipt of a Hackett Studentship from the University of Western Australia, and a Fulbright Travel Grant.

Dr. W. F. Blair and Dr. M. J. Fouquette read the manuscript.—MURRAY J. LITTLEJOHN, *Zoology Department, University of Melbourne, Parkville, N. 2, Victoria, Australia.*

REGENERATION OF ASENSORY LIMBS OF *AMBYSTOMA* LARVAE.[1]—Singer (1949, *J. Exp. Zool., 111:189*) and Taban (1949, *Arch. des. Sci., 2:553*), studying early stages of salamander limb regeneration, independently described a massive neural invasion of the wound epithelium covering the amputation surface. The richly innervated epithelium subsequently became 10–12 cell layers in thickness, forming an apical epidermal cap beneath which mesenchyme cells aggregated to establish the regeneration blastema. Data from several investigations (Thornton, 1954, *J. Exp. Zool., 127:577*; ibid., *131:373*; ibid., *134:357*; ibid., *137:153*) lead to the conclusion that the establishment of an apical cap is a prerequisite for limb regeneration in amphibian larvae. In these experiments formation of an

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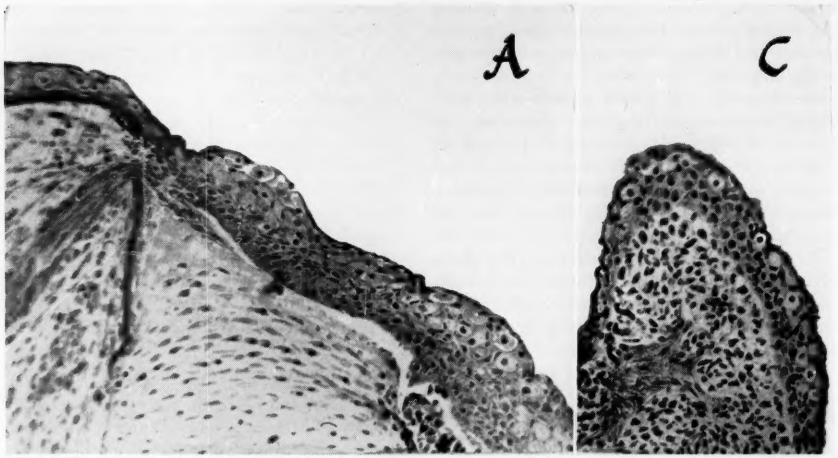

Fig. 1. Photomicrographs of asensory limbs of *Ambystoma tigrinum*. A. Four days after amputation (× 94) B. Eight days after amputation (× 75) C. Tip of blastema 10 days after amputation (× 135) D. Denervated limb 8 days after re-amputation (× 75)

apical epidermal cap took place only if there was massive neural invasion of the wound epithelium. Circumstantial evidence thus pointed to a possible causal relationship between neural invasion of the wound epithelium and the formation of the apical cap. Since nerves (Singer, 1952, *Quart. Rev. Biol., 27:169*) as well as the skin are essential for limb regeneration in amphibians, the demonstration of a cooperative interaction between these two tissues in limb regeneration is important.

An experiment designed by Singer (1946, *J. Exp. Zool., 101:221*) offered a test of the assumption that the physical presence of nerves within the wound epithelium is necessary for an apical cap to form in the regenerating salamander limb. Singer found that a regenerated motor innervation could support fore limb regeneration in adult *Diemictylus* after all sensory nerves had been eliminated from the limb by excision of the dorsal sensory ganglia of spinal nerves II–VI, inclusive. His analysis did not include a study of the wound epithelium. The possibility that there would be little, if any, nerve penetration of the wound epidermis in limbs innervated only with a motor supply seemed promising. Thus Singer's procedure has been repeated using 60–70 mm larvae of *Ambystoma tigrinum melanostictum*. The dorsal sensory ganglia of spinal nerves II–VI, inclusive, were excised on the left side after a parasaggital incision was made through the dorsal muscles and cartilaginous vertebrae. The ventral motor roots of these spinal nerves were sectioned to encourage hyperplastic

regeneration of motor fibers into the left fore limb. Three weeks after excision of the dorsal ganglia, movement of the asensory left fore limbs indicated their reinnervation by motor fibers. Sensitivity tests (pricking the limb with a needle; pinching the various levels of the limb with watchmaker's forceps) disclosed that the left fore limbs of 16 of the 83 operated larvae had received some sensory innervation. These 16 were discarded. The remaining 67 larvae underwent amputation of the asensory left fore limbs. The normally innervated right fore limb of each larva was amputated at the same time and served as a control. All the asensory limbs regenerated normally, although somewhat more slowly than the control right limbs did.

The asensory limb regenerates of 40 of the larvae were re-amputated, fixed every other day beginning on the second day after amputation and ending on the 14th day (6 each day except the last), sectioned at 7 microns, and their nerves impregnated with silver according to the Bodian technique. The muscles of the limbs, seen under the light microscope, were richly innervated but no nerve fibers were in the wound epithelium. Nevertheless, the regenerating asensory limbs developed typical epidermal caps beneath which blastemal cells aggregated in a normal manner. Thus in Fig. 1A, which is a photomicrograph of a longitudinal section through a typical asensory limb stump 4 days after amputation, the wound epithelium of the amputation area has already undergone thickening to 5–6 cell layers. No nerve fibers can be found in this epithelium, although a large nerve trunk passes between the cut edge of the humerus and the wound epithelium. Typically, at 8 days of regeneration (Fig. 1B) a small bulb-blastema has appeared beneath the apical epidermal cap of each asensory limb. Although no nerve fibers are to be found in the apical caps of these limbs, many nerve fibers are present within the blastemata. Nerve fibers are also present in large numbers in the blastemata of all later stages of regenerating asensory limbs; but epidermal innervation is lacking. Thus in Fig. 1C, which is a photomicrograph of a longitudinal section through a typical asensory limb 10 days after amputation, a profusely innervated tip of a cone-blastema is shown. These nerve fibers do not penetrate the epidermis.

A preliminary electronmicroscope study of regenerating asensory limbs by Dr. Elizabeth Hay supports the conclusions derived from this light microscope study.

Finally, the motor nerves of 11 asensory limbs (which previously had undergone typical regeneration) were sectioned, thus depriving the limbs of innervation entirely. All 11 of these limbs failed to regenerate when subsequently amputated. Figure 1D is a photomicrograph of a longitudinal section through one of these denervated limbs fixed 8 days after amputation and illustrates the failure of both an apical cap and a blastema to become established in the absence of nerves.

It is concluded, therefore, that (1) the physical presence of nerve fibers within the wound epithelium of the amputated larval salamander limb is not a prerequisite for the development of a typical apical epidermal cap; and (2) that nerves must be present within the limb stump, however, if a typical apical cap and blastema are to be established.

I am greatly indebted to Mrs. Mary Thornton and to Mr. C. K. Jewell for their expert technical assistance.—CHARLES S. THORNTON, *Kenyon College, Gambier, Ohio.*

REVIEWS AND COMMENTS

PHYLAX TELESCOPUS—IV

Next to atomic research, probably the most expensive type of scientific research is oceanography. The vast sums required to put oceanographic ships to sea, and even to maintain them in port, is almost beyond the imagination of the majority of biologists, accustomed as they are to comparatively small dribbles of research funds. The United States is spending increasingly large amounts of money on oceanography, which is as it should be, for knowledge of the sea is extremely important in these days, not only for military purposes, but also in the hope that oceanic research will in some measure help to solve the frightening world food problems of the comparatively near future.

In this country, the needs and interests of the

Navy have formed the prime lever in obtaining funds for oceanographic research, and late Russian scientific developments and the tremendous effort being put by Russia into oceanography has spurred American efforts and increased the flow of American funds very greatly. However, American oceanographers have not forgotten the arguments for funds that can be based on the need for increasing food supplies. We have personally noted the frequency with which oceanographers use the natural resources-biological argument in pleading for more money. This also is as it should be.

However, the unfortunate truth is that most of the American leaders in oceanography are physical oceanographers, and once they have made the appeal, biological problems appear to recede unduly from their minds and to be provided for, in most instances, only as some sort of necessary but bothersome minor appendage to the physical research. To such criticism, these leaders either give a pitying look to an outsider who isn't "in the know", or, when pushed, begin a bored recitation of all the biological investigations already being carried out under their general supervision. Granted, the number is high, but that is not the point. The point can be seen primarily in the allotment of funds (vastly greater on the physical side) and personnel, and in the fact that, to get a biological problem done, you do not place a physicist in scientific or financial control of the research.

Walford's deep and thoughtful book ("Living Resources of The Sea") has demonstrated that there is no quick and easy way to increase the availability or amount of food resources from the sea. But he also points out, clearly and incontrovertibly, that increased knowledge of the fauna and flora of the oceans is a most basic step in increasing man's use of sea resources. It is in providing adequately for research aimed primarily at increased knowledge of the marine fauna and flora that American oceanographers have fallen down most spectacularly. Hauls of an Isaacs-Kidd trawl made incidentally during physical explorations is no answer. Nor is the placing of one or two junior or student biological oceanographers aboard a vessel assigned to a physical problem. Dr. Anton Bruun of Copenhagen, who is certainly the world's foremost biological oceanographer, has often pointed out that most oceanographic expeditions sorely need an experienced senior marine biologist aboard, unless a great deal of the biological potentiality of the cruise is to be lost.

It is in the loss of such potential biological benefits that many American oceanographic efforts are wasting a great deal of money. As a matter of fact, it seems probable that the wastage is even greater than it appears to be. This columnist knows of at least one institution that readily accepted funds and supervision for extensive biological oceanographic work without knowledge of where it could get the ship or personnel to carry out the program and of other cases in which only one junior biologist was assigned to a project largely for appearance's sake. Yet when this columnist pointed out to the director of one oceanographic institution that well-trained younger ichthyologists familiar with oceanic fishes were in very short supply, he shrugged off the problem, saying that he could hire one whenever needed!

Why is it, for example, that but one trained ichthyologist, and not a single one with experience enough with deep-sea fishes to make extensive sight identifications and observations on habits, has been asked to descend in the Navy's bathyscaphe? Beebe's bathysphere results still biologically overshadow what has been done in America with the bathyscaphe. When fishes form the prime food resource of the sea, why it is that, of our two greatest oceanographic institutions, only one has long had a full-time ichthyologist on its staff. Why is it that not one major oceanographic cruise designed primarily for trawling and dredging both midwater and bottom marine organisms, out of the hundreds of cruises that have been made by them, has in recent years really originated within either of these two institutions? The only answer is the interests of their directorial staffs.

The situation is exemplified by one eminent physical oceanographer with whom this columnist crossed swords during a session of the committee planning the 1959 International Oceanographic Congress. During the discussion of a proposed invitational speaker, this oceanographer asserted that he knew the field of biological oceanography pretty thoroughly and had never heard of the proposed speaker, who therefore could not be of much importance. Yet that proposed speaker happened to be one of the greatest figures in fish hydrodynamics, behavior, habits, and functional anatomy!!

Finally, two features of work in biological oceanography have been entirely forgotten by those currently in control of oceanography in America. One is the enormous amount of work and time necessary in "working up" the biological results of marine collecting. Funds for such purposes are seldom or never asked for, and what material is collected seldom receives adequate study. The other is the unavoidable length of the systematic biological results of even a small cruise and the consequent expense of publication.

Formerly, the "results" of oceanographic cruises were traditionally published in extensive series of quarto-volumes, which, though cumbersome, had the triple advantage of being the only adequate publication form for much of the systematic results, of keeping the results from being widely scattered, and of adding greatly to the scientific prestige of the country which issued them. Modern American physical oceanographers find their results and tables (if they are not "classified" information delivered solely to the Navy) adequately provided for by the publication of short articles in journals or in mimeographed or offset serials. The biological problem has not been met or even seriously considered. Aside from certain results from Alexander Agassiz's expeditions, no American marine expedition has ever had its results published in adequate format since the reports of the U. S. Exploring Expedition (1838–42) appeared! The loss in prestige alone has been enormous.

That oceanographic research depends upon a continuing profusion of short-term governmental grants may be one reason why long-term research and adequate publication of biological results would be difficult to finance. However, other governments seem to be able to find at least the publication funds; witness the imposing continuation of the *Dana Reports* by Denmark, the *Discovery Reports* by Great Britain, and the reports of the Belgian West African expedition! Cannot the richest of all countries do as well? Surely the cost would be but a small item in current oceanographic expenditure.

Most zoologists take some interest in the problem of chordate origin. The latest contribution to this perennial problem is an interesting and suggestive paper by Quentin Bone (1960, *J. Linn. Soc., Zool., 44:252–265*), in which he supports the origin of a tadpole-like larva in the early hemichordates, and the evolution of the urochordates and Acrania (including a notochord and myomeres) from such an ancestor. There is an interesting discussion of the place of *Amphioxus* in the evolutionary picture. The criticisms of the conclusions of previous writers (Garstang, Carter, Berrill, etc.) are instructive, as are the four pages of comment on Bone's paper by Carter and others.

The same issue of the same journal also contains two papers of considerable interest to herpetologists. N. G. Stephenson contributes an informative account of the comparative osteology of Australian geckos (pp. 278–299) and Lynette A. Holder one on the comparative morphology of the axial skeleton in Australian Gekkonidae (pp. 300–335). Stephenson treats the skull, scleral ring, hyobranchial apparatus, pectoral and pelvic girdles, carpus and tarsus, and phalangeal formulae of a wide assortment of Australian and New Zealand gekkonid genera, comparing them directly with a few forms from New Guinea, The Solomons, and Jamaica. The results emphasize the importance of neotenous evolution in the family, a result quite in keeping with the widespread occurrence of the same tendencies in invertebrates and amphibians, and, this columnist may add, in fishes as well. Stephenson finds no osteological support amongst the Antipodal genera for Underwood's division of the geckos into two subfamilies based upon the form of the pupil. Holder's study of the axial skeleton is based upon much the same genera as Stephenson's work. The amphicoelous condition of the vertebrae is regarded as ancestral to the procoelous, but Holder finds that no great structural change is involved in the transition in geckos and suggests that procoely in geckos has arisen separately three times, in the ancestors of *Coleonyx* and related genera, in *Sphaerodactylus* and its allies, and in *Phyllurus milii*.

Ichthyologists and others interested in Tucker's revolutionary reinterpretation of the Atlantic eel problem (see this column, Copeia, 1960, No. 2) may wish to follow up criticism of Tucker's paper by D'Ancona (1959, *Nature, 183:1405–1406*), Jones (1959, *Nature, 184:1281–1283*) and Deelder (1960, *Nature, 185:589–592*). In each instance, Tucker has added succinct defense of this thesis that the differences between European and American eels are purely environmental in origin and that the European population never breeds. After reading these publications and discussing Tucker's thesis with both its author and some competent critics, this columnist tends to side with Tucker in the belief that neither Schmidt's original thesis nor Tucker's reinterpretation is fully provable upon existing evidence; only future work, especially the experimental hatching and early rearing of eel larvae, will permit either thesis to prevail. Persons unfamiliar with the enormous literature cited by Tucker and previous workers are ill-equipped to deal with the problem.

A recent trip to Europe by this columnist has resulted in greater familiarity with the work of the excellent herpetologists and ichthyologists centering in The Humboldt University and Zoological Museum in the Eastern Sector and the Free University of Berlin in the Western Sector of Berlin. Heinz Wermuth is continuing his fine work on the chelonians, his latest being a study of the systematics of *Platysternon* (1960, *Zool. Beitr., Bd. 5:471–482*) in which he recognizes two distinct subspecies of that peculiar Asiatic genus. It may be reported also that the gigantic,

live *Rana goliath* in the Berlin Zoo was in excellent condition when seen in May. This and a beautiful live *Bufo superciliaris* formed the herpetological high spots of the aquarium, an institution superior in most ways to all American public aquariums, and one of which Director Schroeder may well be proud.

On the ichthyological side, Prof. Klaus Günther of the Free University and Dr. Kurt Deckert of The Humboldt University are continuing their collaboration on the functional anatomy of fishes. In their latest paper they carry on their investigation of the elongation of the jaws of bony fishes by a consideration of the viscerocranium of the iniomous fish *Harpadon*, the so-called "Bombay Duck" of India (1960, *Zool. Beitr., Bd. 5:241–280*). In this fish, as in the isospondylous *Malacosteus*, the "neck" must bend as the fish fully opens the mouth (and in this instance shoots the lower jaw forward), and the anatomical peculiarities of this movement are described and figured in considerable detail. However, this columnist would again call attention to the at least external similarity of some of the long-jawed modern teleosts with the Paleozoic palaeoniscoids.

A similar but more extensive paper on the functional anatomy of the jaws and branchial apparatus of *Clupea*, also originating with the Berlin group, became known to this columnist only in Berlin. It is by Helga Kirchhoff (1958, *Zool. Jahrb., Abt. Anat. Ont., Bd. 76:461–540*) and beautifully illustrates and describes the osteological and myological structure and mechanics of the herring.

In the Congo Museum, Brussels, Prof. Max Poll is actively working on the osteology of the African lung fishes (*Propterus*) and reports that he has distinguished (and will soon publish on) a fifth living species of that genus. He also has in preparation, in collaboration with his young assistant, Dirk Thys van der Audenaerde, a paper on the anatomy of that remarkable African fish, *Phractolaemus*. Mr. van der Audenaerde has already published a note on the huge pulmonary air-bladder of the fish (1959, *Rev. Zool. Bot. Afr., 59:364–366*).

In Hamburg, we found Prof. Curt Kosswig to be planning an expedition to Lake Titicaca to study the species swarm of *Orestias*, and in August we heard that he had already left for Peru. He also mentioned a future trip to Lake Lanao, in the Philippines, to study the species swarm of *Barbus* in that lake.

We also learned, from both Prof. Mertens, the now-retired director of the Senckenberg Naturforschenden Gesellschaft and Museum in Frankfurt-am-Main, and from Dr. Wermuth in Berlin, of a new third edition of the check-list of European amphibians and reptiles by these two authors. The new work, of which we saw proof sheets, differs sharply from the first two editions (by Mertens and Müller) in carrying complete lists of primary synonyms and in being published as a separate book by the Senckenberg organization. A formal review is planned for a future issue of Copeia.

Mr. Otto Sokol, formerly of Stanford, has completed his doctorate thesis at the University of Vienna, and is continuing there, on a fellowship, with his studies on the myology, classification, habits and breeding behavior of pipid frogs. He showed us a remarkable cinema film of the breeding behavior of *Pipa*, selected photos from which he intends to use in a paper on the breeding of this frog.

Although new genera and species of fishes are still not difficult to find in many parts of the world, the discovery of a totally unknown family of freshwater fishes at the present day is both surprising and exciting. Such a new family has recently been announced by Dr. H. Stenholt Clausen of Copenhagen and Nigeria (1959, *Vidensk. Medd. fra Dansk Naturh. Foreñ., 121:141–151, 2 pls.*). His new family Denticipitidae is based on a small, schooling, isospondylous fish, *Denticeps clupeoides* Clausen, which he has collected in four smaller, swift-flowing streams in Southwestern Nigeria. Through the courtesy of Dr. Jorgen Nielsen of the Copenhagen Zoological Museum, we have had the opportunity of examining the types and the stained-and-cleared example.

Denticeps is herringlike, but the body is shaped more like that of an atherinid than a clupeid. The fish reaches a length of only about 50 mm. The belly is strongly serrated, the short dorsal fin is set far back, above the middle of the rather long anal fin, and the caudal is shallowly forked. The most striking external characteristic of the fish is the presence, in younger specimens as well as adults of both sexes, of numerous dermal denticles—really teeth—on the exterior surfaces of most of the dermal bones of the head, including the parietals, post temporals and opercles, and the pectoral girdle. Moreover, the skeleton of the caudal base is rather primitive and noticeably heterocercal in nature.

There seems to be little doubt that *Denticeps* can be referred to no previously known family of living teleosts, but we suspect that Dr. Clausen has placed too much weight on the presumed "primitive" nature of the extra-oral teeth. Extra-oral teeth are not known to have been characteristic of early Teleostomi (=Actinopterygii) and

we are inclined to view them in *Denticeps* (as in *Roeboides, Exodon, Tyttocharax, Oedemognathus, Siluroids,* etc.) as specializations, albeit interesting and perhaps early ones. Finally, we would point out the general similarity of *Denticeps* to the Cretaceous fish *C[illegible]riosoma* Schaeffer (1949, *Amer. Mus. Novit.* [illegible] 1427) from Montana, with which it needs comparison, especially in the caudal skeleton.

The above notes on the Denticipitidae had already been written when we arrived in London and found that P. H. Greenwood had in press a paper (1960, *Bull. Brit. Mus. Nat. Hist., geol.,* 5 (1)) describing a new genus of fossil denticipitids from East Africa. In fact, Greenwood already had his fossil material under study when Clausen's paper on the living *Denticeps* appeared. The new fish, *Palaeodenticeps tanganikae* Greenwood, differs from *Denticeps* in only minor characteristics. The extra-oral teeth are remarkably similar in their distribution. The source of the material is a deposit of lacustrine shales of uncertain age in Tanganyika Territory. Greenwood believes the shale to be Middle or Late Tertiary in age. He also finds reason to recognize the Denticipitidae as a distinctive family, which perhaps represents a group of subordinal rank within the Isospondyli.—G. S. MYERS, *London, August 1960.*

COMMENTS

On Research Collections.—Professor George S. Myers has very effectively discussed (Copeia, 1960, No. 3:263–4) the difficult problems that face curators of research collections because of the large numbers of requests they have for loans of materials under their care. I recall a colleague of mine once remarking that being the curator of reptiles in a large museum was like being a shipping clerk in a mail order house. Although Dr. Myers' remarks are worth considering by all who work with collections, an additional statement needs to be made about the underlying reason for the existence of such collections.

I think a distinction between the proprietary and service aspects of museums with regard to their research collections should be emphasized. It is easy to think of a museum's responsibility as being limited by whether it is a municipal or state or private institution and to become involved in legalisms regarding the museum's use of its specimens. I think these matters are secondary, however, to the fundamental nature of true museums and their research collections. I submit that the primary reason museums build up research collections is to advance our knowledge about the materials in their collections. Obviously this involves both the aspect of assembling and maintaining the collections and the fruitful study of, and reporting upon, the materials in the collections. To enhance the advancement of knowledge, curators and directors of museum research collections, regardless of whether supported by philanthropic or public sources, should recognize their responsibility to encourage a wide group of competent investigators to study effectively the materials in their collections. The goal of the museum is to participate and cooperate in the three step process leading to increases in our knowledge: collections, research, publication.

I realize that this point of view does not solve the practical problems referred to by Dr. Myers. I think it is incumbent upon us, however, to first recognize that museum research collections are primarily the basic materials for contributions to knowledge. Science suffers to the degree that avoidable restraints are placed upon the extraction of this knowledge from research collections. Dr. Myers suggests that workers in institutions without collections have no moral or legal right to receive loans from museums without paying for part of their maintenance cost. One might make a contrary observation to the effect that museums have no moral or legal right to expect outside workers to help them accomplish the museums' responsibilities (contributions to knowledge based on objects in their collections) without subsidizing such workers for their efforts.

It is my view that museums do not "own" collections in the proprietary sense; they belong to science. The museum serves as custodian of collections for science.

To summarize briefly: solutions to the practical problems that Dr. Myers outlined will have to be found through temporizing expediencies during our times; nevertheless, curators and directors and others concerned with research collections need to think about the social role of museums and to recognize the basic rationale underlying the development and utilization of their research collections.—ARNOLD B. GROBMAN, *Florida State Museum, Gainesville, Florida*

COMMENTS ON COMMON NAMES OF FISHES

KEY TO THE NAMES OF BRITISH FISHES, MAMMALS, AMPHIBIANS AND REPTILES, by R. D. Macloed, Pitman & Sons, London, 1956, 71 pp. (—/12/6); and **A LIST OF COMMON AND SCIENTIFIC NAMES OF FISHES FROM THE UNITED STATES AND CANADA** (second edition), by a joint committee of the American Fisheries Society and the American Society of Ichthyologists and Herpetologists, American Fisheries Society Special Publ. no. 2, 102 pp., 1960 ($1.00 in paper, $2.00 in cloth; available from E. A. Seaman, Box 483, McLean, Virginia).—These two works are accounts of the common and scientific names applied to certain of the vertebrate animals of Great Britain, and of the United States and Canada respectively. Each includes an account of the names of fishes (and the reviewers must restrict their comments on Macloed's volume to the sections on fishes) and each represents a considerable effort, but here the similarity ends. These two volumes were written by different authors for different purposes; thus the differences in content and presentation are not astonishing. But to the reviewers, these differences reflect also those between scholarship and expediency, interest in a problem and fulfillment of a duty, and understanding of the inherent attributes of the common name and lack of such appreciation.

The first of these two publications has only recently come to the notice of the reviewers, but it is felt that a belated review of this contribution is better than none, as its approach to the problem of common names is so different from that of the American Fisheries Society.

Macloed begins his book with a 14-page introduction in which he discusses, among other things, the purpose and plan of his book, a bit about the origin and derivation of scientific names, and statements on the classification, form and origin of common names. "List I: Scientific Names" begins on page 19. Some 206 generic names are entered alphabetically in the section devoted to fishes, each entry being followed by the name of the author, a brief comment on the derivation of the entry, and some notice of the species and a comment on the specific name or names included under the genus. A total of 360 specific or subspecific names are so treated in the list. All scientific names are given in bold-face for ease of reference.

"List II: Common Names" begins on page 53, and the fish section contains 261 alphabetically arranged entries in bold-face, most of which are followed by the scientific name in italics and a comment as to the derivation. This section is extensively cross-referenced, and in those entries which lack a scientific name, reference is given to another entry. Subentries are given under many of the major entries.

Macloed has combined philological and zoological evidence into an entertaining and well-documented synopsis of the origin and derivation of common and scientific names. He has not prescribed names; he has not tried to arbitrate among competing names, and he has not invented names. He has very simply told us what names now exist and how they came to be; for example:

"**Lamna** Cuvier. Gr. *lamna*, large shark (Oppian: *Halieutika* I, 370). **L. cornubica** (Gmelin), porbeagle. 'Cornish'; coined word with form of L. fem. adj.; not common round Cornwall, though it has been found there and *porbeagle* is a Cornish name." (Macloed, p. 28)

"**Porbeagle,** *Lamna cornubica*. Said to be a Cornish name, compounded of Fr. *porc*, pig, and E. *beagle; porc*, from this shark's gross appearance; *beagle*, from its habit of hunting in 'packs,' cf. *dogfish*." (Macloed, p. 61)

By analyzing common names as they exist, the author has contributed to all of those to whom true common names are appropriately of concern: students of history, anthropology and philology as well as zoology. Our thanks, belatedly, to R. D. Macloed for this most welcome and enjoyable contribution!

The second of the two works is prefaced by a legalistic introduction, the list itself being presented in a generally accepted phylogenetic sequence. Scientific family names are given a common name designation; and within each family the scientific names are listed alphabetically, each with its author, common name and a letter designating Atlantic, Pacific, or Fresh Water, for example:

"Porbeagle A *Lamna nasus* (Bonaterre)" (p. 7)

Part II is an alphabetical index to common names, and includes some widely-used names not "accepted" by the Committee. Part III is an alphabetical index to scientific names.

The reader may be aware that we are approaching the American effort in a somewhat critical sense, and such being the case it behooves us to outline our points of disagreement. The crux of the disparity in the philosophical approach to the problem of common names lies in the definitions of the term common name. The American Committee gives us the following:

"The common name as here employed is viewed as a formal, usually anglicized appella-

tion to be used in lieu of the Latinized scientific name of a species." (p. 1)

We submit that this is an uncritical and superficial use of the term and that whatever its intent, the Committee is "playing with fire". Macloed, in contrast, has considered the matter in a more thoughtful vein and has provided the following:

"Common names may be divided into three main classes according to their origin and the precision of their application, though no hard and fast line can be drawn between them. At one end are book-names, that is to say, names that have been invented by naturalists and, generally speaking, are used only by those who take their zoology seriously. These names are naturally quite precise and refer definitely to one particular species or subspecies. At the other extreme are popular names, that is to say, colloquial names that have grown up spontaneously among ordinary people. Their form and currency are usually both local. As we have already seen, such names have an elastic application and are often used indiscriminately for several kinds of fish or animal. Between these precise book-names and these loose popular names there lies the third class that we may call the ordinary common names. These, like popular names, have grown up spontaneously, but, unlike popular names, are part of the national language and are in nation-wide use. They are, as a rule, definite enough in a generic kind of way, but often too general to denote one species in particular. To overcome this difficulty, such names are often converted into book-names by the prefixing of some distinctive epithet. Thus *Hare* and *Pipe-fish* have been used to form the book-names *Irish hare* and *Broad-nosed pipe-fish*." (Macloed, p. 13)

In their excessively legalistic devotion to self-imposed rules and restrictions, the American Committee has failed to appreciate the fact, implicit in Macloed's discussion of what a common name is, that the term is itself generic in scope. By being, in their definition of common name, lumpers when they should have been splitters, the members of the American Committee have taken a difficult semantic problem, the magnitude of which they apparently failed to grasp, and left it far worse than when they started. The act of attempting to create popular names (Macloed's definition) is doomed to failure, and can only discredit the very necessary functions this Committee should fulfill: that of establishing uniform book names (Macloed's definition) *when the need for such names is clearly mandatory*, and with the full realization that these are book names and nothing more.

Now another objection to the American Committee is their autocratic approach to the problem of common names. This, of course, is a corollary of their failure to comprehend the implications of the term "common name"; nonetheless, when Macloed, when Osorio de Castro (Glossário de Nomes dos Peixes, Gabinete de Estudos das Pescas, Publ. no. 20, Lisboa, 1954), and when the International Council for the Exploration of the Sea (Catalogue des poissons du Nord de l'Europe, Avec les Noms Vulgaires Dont On Se Sert Dans Les Langues de Cette Région, Publ. Circonstance, no. 12, Copenhagen, 1914), among others, report to us what common names *are* used and the American Committee tells us what names they have *accepted* for us to use, we cannot feel otherwise than outraged.

Rather than discuss in detail here a selection of the common names found in this volume, let us examine some of the "ground rules" proposed by the Committee for its own guidance, for these express the philosophy behind the choices found in the list itself. On p. 1 we find:

"The Committee aims at the development of a body of common names that reflect broad current usage, the *creation* of a richer, more meaningful and colorful vernacular nomenclature, and the promotion of mechanisms that will add to stability and the universality of names applied to American fishes." (italics ours)

and on p. 2:

"The Committee believes that it is desirable to establish a common name for each species of fish occurring naturally or through successful introduction in the waters of English-speaking North America."

To this latter end the Committee has invented "common" names by the score if not by the hundred and has dignified with contrived names fishes which are far from common and others which have been known even to ichthyologists for but a few years. We have "common" names galore for groups of fishes still so poorly known that but a handful of professionals can distinguish the species with any degree of facility, while other perfectly good common names (for example all patronyms) have been arbitrarily thrown out. What sort of nomenclatorial twaddle is this?

As for "the creation of a richer, more meaningful and colorful vernacular nomenclature", the list essentially speaks for itself and should require no further comment. We but ask the reader to evaluate a few of these newly-coined common names: "stippled spoon-nose eel", "tropical two-wing flyingfish", "freckled driftfish", "widemouth blindcat", "seaboard goby" and others too numerous to list.

Certainly one of the Committee's statements (p. 1): "It is hoped, and the history of the recent

past confirms, that common names may be more stable than scientific names," will irritate many a conscientious fish taxonomist. In a fauna still under study, name changes are inevitable; however, one of the taxonomist's objectives is a stable nomenclature. In contrast to the Committee's claims to common-name stability, the reader has only to compare the original common name list published by the American Fisheries Society in 1948 with the present list published 12 years later. A few changed names taken at random: *Elops saurus*, formerly bigeye herring, now ladyfish; *Alosa aestivalis*, formerly glut herring, now blueback herring; *Leucichthys artedi*, formerly shallowwater cisco, now cisco or lake herring; *Cyprinodon variegatus*, formerly variegated minnow, now sheepshead minnow; *Sebastodes pinniger*, formerly orange rockfish, now canary rockfish. It is interesting to note that of these five randomly-chosen species with changed names, only two have had scientific name changes within the past 12 years, and these are not at all universally accepted.

Equally unfortunate is the omission of all data underlying the selected choice of the common name. The Committee labored hard and long to select, from among competing names when known to them, the one which seemed most appropriate. Had the competing names and a brief account of the origin and current usage, together with the recommendation itself, been published we might be more disposed to accept the Committee's choices for those species which need a single preferred common name. The publication, however, of single preferred common names, indiscriminately mixed with various invented and replacement names of unstated origin and not identified as such, makes the list all but useless for those more than casually concerned with fish names.

By adhering to a set of principles and criteria which to us seem untenable, and by neglecting to publish the documentation to which the user of such a work is entitled, this Committee has produced a list which cannot be accepted *en bloc*, has entered a field of study not wholly its own and thereby added to the work of others confusion not of their own making, and has abused the common name concept. This need not have been, for the Committee has been formed from among the most expert ichthyologists in the United States and Canada and the List represents considerable effort which might have been directed toward a more satisfactory end. The correspondence and records of deliberations of the Committee must include source material most valuable in the study of American fish names: lists of competing names from which selections were made, local variations and barbarisms, derivations, and other data. There is also a substantial published literature concerned with such names, such as the series of papers by T. N. Gill. We hope that in some subsequent edition of the List, the Committee will restrict its activities to those groups of fishes for which single vernacular names are clearly mandatory and will publish an account of the origin and history of the name or names by which these species have been known.

Although the Committee itself clearly designates the names included as tentative and not nomenclatorially binding, the list will be widely circulated and the names contained therein will gain in usage. It will be on the shelf of many, from secretary to biologist and editor, for a search for a vernacular name, an "approved" name, or a correct spelling, is usually a bothersome irritant associated with a project of more immediate importance, and the list does carry the implied approval if not the official sanction of two professional societies and of the Committee itself. But our best wishes for a speedy recovery go to those true common names which may have been trampled in this superficial attempt at standardization.—GILES W. MEAD, *Museum of Comparative Zoology, Harvard University, Cambridge 38, Mass.*, and DANIEL M. COHEN, *U. S. Bureau of Commercial Fisheries, U. S. National Museum, Washington 25, D. C.*

A LIST OF COMMON AND SCIENTIFIC NAMES OF FISHES FROM THE UNITED STATES AND CANADA (Second Edition)/Report of the Committee on Names of Fishes, Presented at the Eighty-ninth Annual Meeting, Clearwater, Florida, September 16–18, 1959/Reeve M. Bailey, *Chairman*, Ernest A. Lachner, C. C. Lindsey, C. Richard Robins, Phil M. Roedel, W. B. Scott, Loren P. Woods. American Fisheries Society Special Publication No. 2, Ann Arbor, Michigan, 1960: 1–102. $1.00 (paper), $2.00 (cloth). (To be ordered from Mr. E. A. Seaman, American Fisheries Society, Box 483, McLean, Virginia.)—In this edition the Committee on Names of Fishes, representing the American Society of Ichthyologists and Herpetologists as well as the American Fisheries Society, has expanded the coverage to include all species recognized as occurring in "the fresh waters of the continental United States and Canada and those marine species inhabiting contiguous shore waters on or above the continental shelf, to a depth of 100 fathoms." General distribution is indicated by F for fresh water, A for Atlantic Ocean, and P for the Pacific.

This is the first complete North American list

to appear since the publication of Jordan, Evermann, and Clark's check list of 1930, and it fills very real needs. It provides standard vernaculars for all species, which some will feel to be unnecessary, but which I regard as a definite desideratum. The vernaculars have been adopted or concocted in line with a series of generally wise principles, which are fully presented in the introduction. The scientific names have been meticulously chosen, with regard to such items as proper spelling and use of parentheses around author's names. The International Rules of Zoological Nomenclature, as currently understood, have been consistently followed. The sequence is natural down through families, but, for convenience, alphabetical by scientific names within families.

The first edition, which was largely restricted to species of importance in the commercial and sport fisheries, proved to be a real boon to all workers in the fish and fisheries fields, and particularly to popular writers. This edition serves all ichthyologists, and serves them well.

Many ichthyologists will disagree with certain of the systematic judgments that are reflected in the scientific names, particularly in respect to generic concepts. Some choices of vernaculars will be thought ill-chosen. The omission of subspecies (with rare exceptions) will be decried by some, including the reviewer. As a whole, however, it will be generally agreed that debatable points have been thoroughly considered and wise decisions have been reached.

All of us should be enormously grateful to the compilers of the list, particularly to the chairman of the committee, and senior author, Reeve M. Bailey, who, in this labor of love, sacrificed endless hours that might have gone into research. And to all who cooperated in this major task, a hearty "Well done"!—CARL L. HUBBS, *Scripps Institution of Oceanography, University of California, La Jolla.*

REVIEWS

FAUNA JAPONICA/SERRANIDAE (PISCES). By Masao Katayama. Tokyo News Service, Ltd., Ginzo Nishi, Chuo-ku, Tokyo 1960:i–viii, 1–189, pls. 1–86 (20 col.). $10.00

FAUNA JAPONICA/COTTIDAE (PISCES). By Masao Watanabe. *Ibid.* 1960:i–vii, 1–218, figs. 1–74, pls. 1–40 (15 col.). $10.00

Let us hail the rebirth of *Fauna Japonica!* More than a century ago an illustrious Dutchman, Philipp Franz von Siebold, promoted one of the great regional faunal studies. The sections on fishes, amphibians, and reptiles by Temminck and Schlegel have long remained the basis of systematic knowledge of these groups. In the meantime a plethora of special papers, with some special monographs, have been published, first largely by foreigners, more recently by the notably industrious and able Japanese systematists. These contributions have appeared in many languages, and recently, to the dismay of most biologists, in the Japanese language, which very few biologists understand or can be expected to master. So, let us further rejoice in that *Fauna Japonica* is appearing in English, the most nearly universal language. We owe the authors along with their distinguished contributors and compilators, and their generous sponsors and publishers, our profound thanks for the publication of this work in English, which has been carefully edited to eliminate common Japanese-English idioms (though some, such as the use of singular nouns when the plural is meant, occasionally appear) (no translocations of *l* and *r* are noted in this work). Proof-reading, which must be difficult in Japan, has generally been excellent.

The two initial volumes on fishes bear the imprint of two collaborators, my distinguished friends Yaichiro Okada and Kiyomatsu Matsubara (I take pride in having inspired Matsubara into ichthyology). The compilators, in addition to Okada, the head of the group, representing the Biogeographical Society of Japan, are Tokuichi Shiraki (representing the Entomological Society of Japan), Nagamichi Kuroda (Mammalogical Society of Japan), Tohru Uchida (Society of Systematic Zoology of Japan), and Dr. Yoshimoro Yamashina (Ornithological Society of Japan).

The excellence of the text, of the printing and binding, and especially of the magnificent plates, will incite the envy of systematists in other lands, which despite their larger army of scientists and greater wealth somehow can not seem to produce and afford such treatises. In the volume on the Serranidae all 15 subfamilies, all but one of the 38 genera, and all but 8 of the 90 forms, as recognized, are beautifully figured.

But from the world standpoint these works have some limitations, foremost of which is the almost complete limitation of the researches by Japanese zoologists to the geographical limits of the Japanese empire, which have varied in response to military and political events. This re-

striction has been applied to a degree in line with Japanese tradition, in general as well as in systematic biology, to several outstanding previous group monographs of fishes, including the one on the Scorpaenidae by Kiyomatsu Matsubara and the one of Rajidae by Reizo Ishiyama. No doubt our Japanese colleagues will in time devote to broader fields their genius for incessant labor, thoroughness, and attention to detail (Ishiyama, for ichthyology, is just now breaking out into less provincial fields, by working with us on the Rajidae of the northern and eastern Pacific). Future monographs of Japan animals will be enriched, we trust, by zoologists who have studied their special groups throughout their ranges. We are happy to hear from Dr. Okada that the third volume in the new "*Fauna*" will be by Ishiyama, on the Rajidae.

Two initial fish monographs, which inaugurate the new *Fauna Japonica*, are similar in the complete coverage of the Japanese species, the great majority of which are magnificantly figured. The resemblance involves also a conservative view of broad family limits (in which I concur), with a multiplication of subfamilies. The classification in each family is indicated as having been based on the study of internal characters, though the evidence is here presented only in the monograph of the serranids. In other respects the treatment of the serranids is the more satisfying: the descriptions cover series, rather than, in line with a common practice in Japan, a single selected specimen (supplemented, to be sure, by a useful table of limiting counts and measurements); synonymies are given for genera and are more complete for species; the distributional data not only for Japan, but in general, are not only much more complete but are well documented (Watanabe sketched only the distribution, within Japan; characters in the keys are commendably more complete and more strictly coordinate in pairs of rubrics). A shortcoming of Katayama's monograph is the complete failure to indicate sizes attained; Watanabe did give the size of the specimen described and the size range of those measured.

Katayama's monograph on the Serranidae is almost entirely original, for he has published only a few preliminary papers on the family. Watanabe's treatment, on the contrary, was preceded by his 1956 publication, of 461 pages and 124 plates. In fact, most of the species he then named are repeated, contrary to the International Rules, as "*n. sp.*" in the present treatment.

In neither volume is there any treatment of geographical variation, and the only subspecies that are recognized are nongeographical variants, in two species of Serranidae, that will more likely prove either full species or to be unworthy of recognition.

To illustrate the expansion in the knowledge of the Japanese fish fauna over the past several decades, largely due to the extensive collecting and taxonomic analyses of our Japanese colleagues, we note that between last, previous (and first) monograph of the Serranidae (by Jordan and Richardson, in 1910) and Katayama's treatment, the subfamilies have been increased from 7 to 15, genera from 17 to 38, species from 29 to 88. Between Jordan and Stark's review of the Japanese cottids in 1904 and Watanabe's account the increase has been from 6 to 12 subfamilies, and from 57 to 74 species; the recognized genera have decreased from 40 to 36, through a preponderance of fusion of genera over new discoveries.

The known Japanese fauna is developing into one of the richest in the world, due primarily to two factors, that are illustrated respectively by the Serranidae and the Cottidae. The serranids of Japan owe their richness to their proximity to the, "great mother fish fauna of the world" that of the Indo-Pacific, and to the bathing of Japan by the Kuroshiwo; the cottids of Japan owe their richness to the equally impressive speciation, among the temperate to boreal regions, of the North Pacific Fauna, and to the southward bearing Oyoshiwo. For both families further diversity in Japan is attributable to the great range in latitude and temperatures, bridging the tropical with the boreal, and to the diversity of shoreline habitats. Some discussions of this sort would have enriched the monographs under review.

Katayama's extensive data on osteology allow a test of the belief commonly held since the time of Boulenger that $10 + 14 = 24$ is the standard and basic vertebral formula of acanthopterygian fishes. He accepted this view, and stated in the description of the family Serranidae: "Vertebrae typically 24, of which 14 caudal, number sometimes increased, never over 37." Although there is certainly a tendency for the seemingly more primitive or oldest known forms in various spiny-rayed fish groups to have $10 + 14$ vertebrae, exceptions seem to be more numerous than some have long thought. Taking Katayama's data on subfamilies to apply to the few genera for which he omits the vertebral formula, and assuming that all species in a genus agree with his statement for the genus, and accepting his classification for the present purpose, we find that of the 15 subfamilies only 5 have $10 + 14$ vertebrae, whereas 9 have more than 24 and 1 has $11 + 13$; of the 38 genera 12 have $10 + 14$, 24 have more than 24, 1 has $11 + 13$, and 1 is unrecorded; of the 88 species 48 have $10 + 14$, 38 have more

than 24, 1 has 11 + 13, and 1 is unrecorded. The circumstance that the proportion of taxa with 12 + 14 vertebrae increased in the lower categories is due to the speciosity of the Epinephelinae.

All institutions and individuals concerned with or likely to be involved in systematic zoogeographic researches on marine fishes should procure these two volumes, and libraries should subscribe to the whole series. Considering the excellent bookmaking and the numerous plates in color and black and white, the obviously subsidized price of $10.00 per volume is a bargain.

Again, let us thank our Japanese colleagues for this auspicious inauguration of a large, bold, and eminently worthwhile project and hail them for their labor of love.—CARL L. HUBBS, *University of California, La Jolla, California.*

HANDBOOK OF HAWAIIAN FISHES. By William A. Gosline and Vernon E. Brock. University of Hawaii Press, Honolulu, ix + 372 pp., 277 figs., 4 col. figs., map on end papers, $11.00.—The authors modestly intend their handbook to provide interested persons with identifications of Hawaiian fishes. It is also a faunal report of major importance and as such demands close attention by all students of marine fishes. The 1500 mile Hawaiian chain from Kure and Midway to Hawaii, and Johnston Island 450 miles to the south are included. Fish faunas of other Pacific island areas have been reported on in the past. Indeed, Hawaiian fishes have been considered on several occasions. The history of previous ichthyological work in Hawaii is discussed in the introduction by Gosline and Brock. The basic difference in the *Hawaiian Handbook*, and the feature that sets it far above previous efforts, is the familiarity of Gosline and Brock with Hawaiian fishes. This is not a report based on collections accumulated by previous expeditions, this is not a report based upon faded material culled from museum shelves, nor is it a report based on a few weeks or months of efforts in the field by the authors. It is a report based on a fauna of backyard familiarity to them. This fauna has furnished Gosline and his students with teaching and research material for twelve years and Brock and his team of personnel with the basis for important research programs since 1949. The result is a varied union of systematic, ecological, biological and zoogeographical information seldom possible in a faunal report. The reviewer intends no critical comments on other faunal studies but wishes to emphasize this especially creditable feature of the *Hawaiian Handbook*.

This must be the most complete compilation of fish species for any island group in the expanse of the tropical Indo-Pacific region. A total of 599 species of native Hawaiian fishes (15 not known north of Johnston Island) are considered exclusive of some of the 136 deepwater fishes known only from Gilbert's report (1905). Appendix B provides references to and partial synonymies for all species, however. Additional new species and new records of shore dwellers may be expected but they will be few indeed. More additions to the Hawaiian list are to be expected in deeper water. Zoogeographers, who have attempted so much on fragmentary evidence, may now confidently remark on the fish fauna of the Hawaiian Islands and its composition.

Species accounts are succinct; they emphasize salient features of identification and provide varied remarks on economic importance, habits and habitat. Line drawings depict about 300 species and colored photographs of 11 species are included on the cover page and the jacket. All drawings are simple, but well done, and distinctly aid identification. Color is of consequence in identifying some inshore groups (*e.g.*, gobies, wrasses, parrotfishes) and it is therefore disappointing to find so few colored figures. If any one feature should be emphasized in a future edition, it is the need for colored plates.

Keys are provided first to the families of Hawaiian fishes and then directly to species within each family or group. The vagaries of generic names are thus spared the reader. The inclusion of cross pagination in the family keys and references to pertinent figures are welcome features, often lacking in guide books. Keys to the families are brief, carefully written and easily understood and those to species vary in complexity with the complexity of the group. No one can rightfully expect a simple answer to the Holocentridae or the Muraenidae and none is forthcoming. The keys employ life colors along with morphology (the field worker can shortcut and the museum worker is not excluded), and they do work!

A discussion of methods, and characters employed in fish identification precedes the family key. The section is written for Hawaiian fishes and Hawaiian examples are used but its application is broad; the families represented are common components of tropical seas around the world. The laboratory student in ichthyology at Miami, for example, will profit more from this clear account than from treatments based on freshwater or northern fishes.

Ichthyologists should direct particular attention to the general remarks given for most families and some genera. New information is contained in some and others ably summarize problems that are met by students of tropical

fishes everywhere in the world. A fitting example may be found in the eels, a group that has trapped more than one ichthyologist; the accounts of the Muraenidae and *Echidna* and *Gymnothorax* are especially pertinent. The authors' varied backgrounds and interests (Gosline with non-commercial and Brock with commercial groups) give depth to the book. In addition, specialists authored sections on three groups: Yoshio Yamaguchi (Carangidae), John E. Randall (Acanthuridae) and Donald W. Strasburg (blennioid fishes). Again their opening remarks are important. The three sections fit comfortably in the general format of the book.

The nomenclature employed is, of course, up to date. Some readers will wonder about the retention of *Neothunnus, Parathunnus* (but not *Germo*) and *Katsuwonus,* but these are matters of opinion and opinion is unsettled. English and/or Hawaiian names are provided for the better known species. All names are indexed.

The ecology of Hawaiian fishes (Chapter 2) is a fertile passage, filled with new information on the distribution and habits of native species. The ease with which examples are dealt previews a strong source of unreported information.

An isolated chain of oceanic islands lying on the outskirts of the main Pacific island areas, the Hawaiian region holds considerable interest for zoogeographers. Being so isolated it is not surprising that 34 percent of the fishes are endemic. There is no marked differentiation of populations within the region. Also, differentiation of Hawaiian fishes is at the species level; only three genera are endemic and these may prove invalid when tropical marine fishes become better known. This is in sharp contrast with the distinctive terrestrial fauna. Of course some endemics may not have differentiated after reaching Hawaii for as the authors note (Chapter 3) there are relicts whose closest relatives appear in the West Indian (*e.g., Chilorhinus, Holocentrus scythrops*) or other distant regions. The origins of the fauna are mixed and uncertain, a feature usually apparent in a waif fauna. The treatment accorded the nature and derivation of the Hawaiian fish fauna, like all sections, is brief, clear and to the point. The authors did not succumb to temptation, and belabor percentages and invasion routes, an action that would have muddled their principal message, and this reader, at least, is grateful.

In a day when almost any book or pamphlet on fish and fishing secures some sales success, the authors are to be congratulated for taking time to prepare a high quality and authoritative volume, a genuine contribution to all, from skindiver to ichthyologist, who are interested in fishes.

Finally, the reviewer wishes to lay his one attack on the publisher whom we must presume responsible for the cost of $11.00. This price is not consistent with the simple format and dearth of colored figures. The *Hawaiian Handbook* has high appeal to marginal groups (all skindivers, sportsfishermen, tourists) but many would-be purchasers will be discouraged by the cost. Printing was in Honolulu, and printing costs may be higher in the islands but surely lower prices could have been obtained elsewhere.—C. RICHARD ROBINS, *The Marine Laboratory, University of Miami, Miami 49, Florida.*

FRESHWATER FISHES IN MISSISSIPPI. By Fannye A. Cook. Mississippi Game and Fish Commission, Jackson. Hederman Bros. printers, 1959: 239 pp., 2 maps, 43 figs., 4 tabs., paper. $3.00.—As stated in the preface, this book is the only one that deals exclusively with all of the freshwater fish species known to occur, or to have occurred, in the state of Mississippi. It includes 38 species of marine fishes that most frequently enter fresh water. Its purpose is to meet current demands for information relative to the fish life of Mississippi.

The subject matter is divided into 14 unnumbered parts: (1) *Nature and source of information* (pp. 7–12) relates in chronological order to the major publications dealing with freshwater fishes in Mississippi and includes the extensive field observations and researches of the late Dr. S. F. Hildebrand, the many and largely unpublished findings of the author, her students and colleagues, and of members of various state and federal organizations. (2) *Watersheds and stream systems* (pp. 13–17) contains brief but adequate descriptions of the 12 principal watersheds occurring entirely or in part in Mississippi. (3) *Waters in Mississippi from which fishes treated in this bulletin have been collected* (pp. 18–25) is a verbal list by river systems of the localities where fishes were collected; there is a map of the state showing the collection stations of S. F. Hildebrand, O. P. Hay and the author. (4) *Some characteristics of fishes* (pp. 25–26) briefly describes various habitats, the numbers of eggs produced and the economic status. (5) *Structures used in identification* (pp. 26–28) discusses the fins, scales and various body parts of fishes and includes a figure of the topography of a fish, and another of its head, both well done. (6) *Explanations of measurements, abbreviations, enumerations and symbols* (pp. 29–31) is quite adequate. (7) *List of freshwater fishes of Mississippi* (pp. 32–35) lists the scientific and English names of 152 species and 5 additional subspecies; these are in 21 families. (8) *Salt water*

fishes which invade fresh water (pp. 36–37) lists 38 species in 22 families "which might be found at times in the freshwaters of the state." The list was drawn up by Dr. Gordon Gunter. (9) *Fishes originally described from Mississippi* (pp. 37–39) is an annotated list of 29 fishes whose type locality is in Mississippi; of these 11 have been placed in synonomy. (10) *Key to the families of freshwater fishes found in Mississippi* (pp. 40–42) is a concise, workable, multi-character key. (11) The body of the book (pp. 43–213), without a title, describes some characteristics of the families and their relationships to other families; economic importance of some families commercially, as sport or as bait, and as forage for other fishes. If a family or genus contains more than one species in the waters of Mississippi there is a multi-character key of these species. This is followed by the English and scientific names and a general account of each species with the latter often including statements concerning sexual development and characteristics, breeding habits, general distribution and abundance in Mississippi and/or elsewhere, meristic counts, measurements, variations in body proportions, maximum size and weight attained, and where important collections were made. Occasionally there is a discussion of a genus such as that of *Hybopsis* (p. 128). (12) *Glossary* (pp. 214–18), the definitions of which are clearly stated. (13) *References* (pp. 219–28) contains a bibliography of 179 titles. (14) *Index* (pp. 229–39) is adequate.

There is much to be admired in this book, not the least of which is the very apparent determination of the author, despite distractions of divers sorts, to do a conscientious, thorough job. That she has done. It is obvious that she painstakingly sifted over the data and carefully examined the specimens. Sometimes she sought verification of her identifications or suggestions from others. Notable among such persons is Dr. Reeve M. Bailey who identified some specimens of most of the species. The result is a work, containing a current classification, which will be useful for many years.

I find little to criticize. Typographical errors are few. It might have been better to refer such species as *Scaphirhynchus album* and *Carpiodes cyprinus* to a hypothetical list since apparently no specimens taken from Mississippi waters were examined. Since the avowed purpose of the book is to assist anyone interested in Mississippian fishes to recognize them, its value to the layman would have been enhanced greatly by more drawings of fishes because the layman, unacquainted with the technical jargon and quirks of verbal keys finds diagrammatic drawings a more positive method of identification. Also, the ichthyologist would have welcomed especially drawings of those southern fish species of which there are no satisfactory drawings to be found in the literature. Unfortunately drawings are expensive.

Altogether, Miss Cook is to be congratulated upon a job well done.—MILTON B. TRAUTMAN, *Department of Zoology, The Ohio State University, Columbus, Ohio.*

HANDBOOK OF COMPUTATIONS FOR BIOLOGICAL STATISTICS OF FISH POPULATIONS. By W. E. Ricker. Fisheries Research Board of Canada, Bulletin no. 119, Under the Control of the Honourable Minister of Fisheries, Queens Printer, Ottawa, 1958: 300 pp. $5.00. Cloth.—This book demonstrates the existence of a field of biological resource engineering that has almost the same relation to ichthyology and ecology that nuclear engineering has to nuclear physics and electronics. Fisheries biology problems are now well enough organized so that disputes, polemics and order of magnitude conclusions have been by-passed. Ricker assumes that the questions asked by fisheries workers are predictable and finite in number. He further assumes that most fish populations will meet fairly simple assumptions. The biological consequences of these assumptions are then deduced mathematically, with the more tedious computational steps expedited by tables at the end of the book. The fisheries biologist must decide which assumptions are relevant to his particular population and then follow the indicated procedures to arrive at the required answers.

In areas in which questions of applicability of various theoretical formulations may arise the difficulty is simply pointed out, without any particular attempt at resolution, just as a text on civil engineering might contain precautionary notes relative to some particular procedure.

Where estimates are subject to errors of interpretation Ricker very wisely points out that often the change in the estimate from year to year is of greater significance for fisheries management than whether or not the estimate is really what it purports to be.

This approach is of highest value in answering relatively simple questions. As questions increase in difficulty the practical differences engendered by the simplified biological assumptions may become more important. In particular, in dealing with the theory of maximum equilibrium catch Ricker divides his examples according to which assumptions have been made. He envisions either constancy of growth rate, natural mortality rates and absolute number of recruits or releasing the assumption of constancy for either

recruitment or growth rate. Of course as the simplifying assumptions are abandoned the mathematical complexity of the population model begins to outstrip both the mathematical competence of most biologists and the power of the existing data to discriminate between alternative models. Nevertheless, in particular fisheries it may be expected that complex functional relations between stock age structure, abundance, growth rate and recruitment will exist. The failure to handle these complex situations does not constitute a real weakness since range of applicability is very quickly lost with increasing complexity.

While the first chapter provides a general theoretical framework, the remaining 11 chapters provide detailed examples of the solution of specific problems. The table of contents is sufficiently detailed to serve as a general guide to types of problems. There is in addition an Index, extensive bibliography and extremely handy tables of the exponential functions normally used in population analyses.

Of necessity there is a confusing richness of symbolism but this confusion is minimized by an initial symbol glossary and redefinition of symbols in the body of the text as they are used.

The obvious book, in English, with which this one will be compared is that of Beverton & Holt. (1957, On the Dynamics of Exploited Fish Populations, Ministry of Agriculture, Fisheries and Food, Fishery Investigations, Series II, Volume XIX, Her Majesty's Stationary Office. 533 pp.) The comparison is not quite legitimate since Ricker has produced a handbook, in which computations and estimation procedures have been kept as simple as possible, while Beverton and Holt have produced an occasionally very complex theory of population dynamics. Ricker's book is of greatest value to the field worker in a specific fishery or to a course in fisheries management. After thorough comprehension of Ricker's work, the student is ready to take on Beverton and Holt with greater profit.—L. B. SLOBODKIN, *Department of Zoology, University of Michigan, Ann Arbor, Mich.*

THE RUSTY LIZARD, A POPULATION STUDY. By W. Frank Blair. University of Texas Press, Austin. xvi + 185 pp., 31 figs., 1960. $4.50. —This book is based upon a field study extending from August 4, 1951, to October 30, 1956 in a ten-acre area about Dr. Blair's home on the outskirts of Austin, Texas. Natural vegetation consisting of brush and open groves of small trees along with buildings, fences and other artificial features made up the habitat of the lizards. More than 3,000 individuals were captured, marked, released, and observed. The great amount of field work involved was shared by several graduate student assistants, and by the author's wife.

The rusty lizard is *Sceloporus olivaceus*, better known to many herpetologists as the Texas spiny lizard, but the author does not follow consistently the ASIH check-list of vernacular names.

Throughout the book the viewpoint is ecological. Major chapter headings and topic headings are: The Environment (Climate and Weather, Soil and Topography, Vegetation, Vegetational Changes, Animals); Adaptation at the Individual Level (Size, Growth, Molt, Tail, Scales, Feet and Claws, Color and Color Pattern, Eyesight, Hearing, Temperature Relationships); Adaptation at the Population Level (Breeding Population, Reproductive Potential, Effect of Environmental Resistance); Organization of the Population (Sex Ratio, Individual Movements, Dispersal, Social Relationships); Significance of the Study (Comparison with Other Species, Bearing on Basic Ecological Problems).

Lizards were captured by hand, by trapping, and by noosing. It is noteworthy that the noosing was accomplished with No. 30 linen thread instead of with the copper wire loops that have been found highly effective for catching *Sceloporus* and related kinds of lizards, by many other workers. In Chapter 2 the climate, vegetation and associated animals are discussed in considerable detail. However, information is lacking concerning the significance of many of the environmental factors mentioned in the ecology of *S. olivaceus*. Some 56 species of vertebrate associates are listed but many fall in the category "Relationships unknown"; the others are "Possible or known users of same foods", or "Possible or known predators". For relatively few species were direct interactions with *S. olivaceus* actually observed. However, the patch-nosed snake (*Salvadora lineata*) was recorded preying on the eggs or young on various occasions, leading to the conclusion that this snake is a major factor in the destruction of clutches of eggs and newly hatched young. More than three-fourths of the clutches laid are destroyed completely, mostly by vertebrate predators.

In Chapter 3 most of the topics are discussed thoroughly, but hardly any significant information was obtained regarding "Hearing". It is implied but not definitely stated that hearing is of minor importance to the lizard. The section on "Body Temperatures" begins with the statement: "The body temperature of the heterothermal rusty lizard is close to that of the external environment", and this theme is then developed, seemingly with little cognizance of the fact that

these lizards constantly practice behavioral thermoregulation, and that the temperature during periods of activity normally is maintained within the fairly narrow range that is preferred. C. M. Bogert's study of temperature in *Sceloporus* of other species (Evolution, 3:198) is not cited, but Blair's records seem to bear out Bogert's findings that body temperatures in the neighborhood of 35° or 36° Centigrade are preferred by members of this genus. The author considers the home range in *S. olivaceus* to be the area encompassed by several separate "stations"—objects such as trees or fence posts upon which this scansorial lizard may climb and bask. Such an area does not conform with the usual concept of a home range, as the spaces between stations ordinarily are not used by the lizards. The home range of an individual of *S. olivaceus* might be alternatively visualized as the sum of several disjunct segments—the stations and their immediate environs—but not all of the intervening areas. The author seemingly does not consider this species of lizard to be territorial. However, simultaneous use of the same station by two adult males results in fighting, and one is soon driven away. Even in the young there is mutual intolerance. In view of this behavior, a station, while it is occupied, could well be regarded as a limited and temporary territory within the home range.

Chapters 4 and 5 setting forth the information gained concerning populations, comprise the core of this report. Because almost every lizard on the study area was captured one or more times in each year of the study, the composition of the population according to sex and to age groups could be shown. Also, the changes that occurred within a season, and from year to year could be traced. Plausible explanation for the latter changes is offered on the basis of changes in the environment, but definite proof that drought, for example, brought about the observed decrease in number of lizards, was lacking. In certain instances figures pertaining to the population were obtained by extrapolation. For instance the number of eggs produced each season on the ten-acre area was calculated on the basis of the number of adult females known to be present and the known productivity of individuals in each age class; yearlings typically produce only one clutch of 8 to 15 (average 11.3) eggs while old adults may produce more than 100 eggs (in four clutches) per season. Numbers of young hatched could not be determined directly since the newly hatched are eliminated at an especially rapid rate, and many do not survive to be caught by the investigator. However, Blair has supplemented the incomplete figures obtained for those actually caught, by two different methods. With one method, figures are projected from the numbers of young surviving to different stages of growth in broods all of whose members were marked immediately after hatching. With another method, total number of young hatched each season was calculated from the number of eggs estimated to have been laid, and from the ratio of eggs lost to predators, desiccation and other causes in the sample clutches that were kept under observation. The figures obtained by these different methods were of the same order of magnitude, but with a substantial margin of error—more than one-third in some instances.

In a compromise between a strictly observational study on a natural population, and a study with extensive experimentation and manipulation that might have altered the population, the author fenced in many known nest-sites to prevent or reduce destruction by predators and to confine the hatchlings until they could be marked. In some instances Blair even moved entire clutches to sites more favorable than those selected by the mothers. The young of these entire broods, marked just after hatching, were remarkably productive of valuable data pertaining to growth, survival, dispersal, and other phases of the natural history.

A report of outstanding merit has resulted from the able efforts of Dr. Blair and his coworkers on a species almost ideally adapted for such a study by reason of its unusual abundance and availability, and the facility with which it may be observed. As the author states, the understanding attained of this species's population dynamics is more complete than that previously attained for any other kind of lizard. In fact few species of animals have been subjected to such searching and detailed population analysis. For a long time to come Dr. Blair's book on the Texas spiny lizard will be one of the important references in the field of population ecology. —HENRY S. FITCH, *Department of Zoology, University of Kansas, Lawrence, Kansas.*

"INVERTEBRATE ZOOLOGY" by Victor Schechter, Prentice-Hall, Inc. 1959, 530 pp.—The term "invertebrate" is one of convenience, since it is a contrasting term to "vertebrate." Invertebrates comprise about 97 percent of the described species of animals, and all phyla except that portion of Chordata that has a segmented backbone. Hence a book on invertebrate zoology has as a potential subject almost the whole of the animal kingdom.

There are many approaches possible in dealing with so broad a field. The present author is

particularly interested in tracing the evolutionary development of specialized locomotory organs. "The big difference between plants and animals, is in their ability to move about; and animal evolution revolved around adaptations for locomotion" (p. 506). Or again, "It might be said that the chief function of the body is to carry the alimentary canal from place to place in search of food" (p. 115). Of course, rapid movements in an animal require the perfection of other systems—sensory, circulatory, digestive, excretory, respiratory and reproductive. Having a basic integrating concept in mind has made this text a better book than it could have been without such an approach.

The book presents a rapid survey of 25 phyla of invertebrates. Five groups are given 40 or more pages each of text—protozoa, cnidaria, platyhelminths, and the arthropod classes crustacea and insecta, while small unusual phyla are treated briefly. Taxonomy is not stressed despite the fact that the author assures us that "we should not look down on taxonomy, nor regard it as a burdensome chore. Taxonomy is as essential to the effective pursuit of other branches of biological endeavor as is classification of books in a library" (p. 6).

Care has been taken with the format of the book. The text of each chapter begins on the right hand page, for example, and the facing page has an interesting photograph. The figures in the text range from good to passable. There are 40 full page illustrations and many part page illustrations, most of which could have been presented in smaller compass. Many of the illustrations are obviously copies from other sources, but these are not acknowledged.

The author has been careless about many of his facts. The point can be made by citing lapses that occur on two consecutive pages (pp. 145–146) dealing with a discussion of hydrozoa (Phylum Cnidaria). In discussing life history of the hydrozoa the statement appears "while gamete formation is a property of medusa and budding is not, as in all natural phenomenon an exception can be found since medusae of the genus *Rathkia* are known to form buds" (p. 146). If the author had consulted F. W. Russell's excellent book on "Medusae of the British Isles" he would have learned "Asexual budding is a common feature among medusae, especially in the anthomedusae" (p. 8). At the same time he would have found that his statement on p. 145, "budding never produces a polyp" in Corymorpha was refuted by Russell who stated "Allman has recorded reproduction in the hydroid, *Corymorpha*, by asexual budding and it is possible that considerable fields of the hydroid may be deveolped in this way" (p. 89). *Liriope* is singled out as unique in not having a polyp phase (p. 146). Actually, lack of a polyp stage is characteristic of most Trachymedusae and Narcomedusae. Such errors or distortions of fact were noted throughout the book.

A shortcoming of the book arises from the fact that the author is shorebound. He apparently has no more than a nodding acquaintance with the vast pelagic realm that occupies 70 percent of the earth's surface. Copepods, which are probably the most numerous of animals, are given a third of a page of text and two illustrations. One of these illustrations is transposed (figures 2.31 and 18.3, *Calocalanus* and *Polystomella*, the latter is an invalid name); the other is an inexact drawing of "Cyclops" (note the number of segments in the swimming antennae, for example). Mysids don't make the book, neither do euphausiids. Among the primitive chordates, salps and doliolids, that are at times so abundant in the ocean that they increase plankton volumes by several orders of magnitude, are not mentioned. The doliolids should have been included for their fascinating polymorphism, if for no other reason.

Some mannerisms of the author may be annoying to some readers. We are willing to take for granted that phyla included in the book are considered of importance by the author. Hence he doesn't have to convince us that the "wonderful little animal," the rotifer, "is well worthy of a little of our time" (p. 228), or need he tell us "let us not be too hasty in our judgment of the Parazoa" (p. 94).—ELBERT H. AHLSTROM. *Biological Laboratory, Bureau of Commercial Fisheries, La Jolla, California.*

LES BATRACIENS DU MAROC. By G. Pasteur and J. Bons. Travaux de l'Institute Scientifique Chérifien, Rabat. Zool. Ser. No. 17, 1959, ix + 241 pp., 43 figs., 3 pls., 1 map. This work is addressed to people interested in Moroccan amphibians, whether professionally or not. There is a general section dealing with the biology of amphibians and a set of keys, followed by detailed accounts of the species. The general section includes chapters on what an amphibian is and how the Moroccan forms are classified; morphology, largely external; physiology, particularly as related to environment; natural history; demography; relations of amphibians and man; zoogeography; and practical considerations, including how to capture, raise, study, and preserve amphibians. These chapters, together with the keys to adults, larvae, and eggs, provide the nonprofessional with an introduction to the study of Moroccan amphibians.

Accounts of the two kinds of salamanders and eight kinds of frogs found in Morocco comprise about half of the book. These accounts are both a report on the status of knowledge about Moroccan forms and a source of otherwise unpublished data. They include a description of the Moroccan form; notes on sexual dimorphism, voice, distribution, life history, growth, and longevity; descriptions of eggs and larvae; and tables of measurements. Data based on non-Moroccan material or on captive specimens are included in some of the accounts.

Taxonomic and zoogeographic considerations of the various forms are of interest particularly to the professional herpetologist. A new species of spadefoot, *Pelobates varaldii*, is described; the Moroccan form is close to *P. cultripes* of the Iberian peninsula and southern France, and was originally reported as that form. The authors follow Kauri in considering *Rana esculenta* and *Rana ridibunda* conspecific; they assign Moroccan specimens to *Rana esculenta ridibunda* rather than to *R. e. perezi*, the Iberian peninsula form. They suggest that *Rana esculenta bilmaensis* is a Sudanese species rather than a form of *Rana esculenta*, both on geographical and morphological grounds.

An interpretation of the origin of the Moroccan fauna is offered in the zoogeography section. The amphibians are, with the possible exception of *Bufo mauritanicus*, palearctic. Since seven of the Moroccan forms have identical or closely related forms in the Iberian peninsula, the authors believe that most of the palearctic amphibians (*Rana esculenta ridibunda* being the only definite exception) migrated south into Morocco from Europe. The presence of closely related forms in Morocco and Spain indicates to the reviewer, however, only that the Straits of Gibraltar have been crossed; it does not *per se* indicate the direction of crossing.

An alternative explanation has been offered by Parker (*Syst. Assoc. Publ. 2:9–15, 1956*) to account for the distribution of *Hyla arborea* and *Rana ridibunda*. The authors accept Parker's explanation only for the *Rana*, in which the population of *Rana e. ridibunda* in Morocco is intermediate between *Rana e. esculenta* east of the Pyrenees in Europe and *R. e. perezi* in the Iberian peninsula. This intermediacy of the African form holds regardless of taxonomy. Parker's explanation is rejected by the authors for the *Hyla*, but the Near Eastern form is again intermediate between the Morocco-Iberian peninsula form and the eastern European form. A similar explanation might be used to account for the distribution of the species of *Pelobates*. The situation in the other forms is not necessarily antagonistic to this hypothesis.

It is tempting to speculate that taxa centered in Morocco and the Iberian peninsula and related but conspicuously different taxa centered in central Europe represent terminal populations in present or former subspecies rings circling the Mediterranean. A shift to arid conditions in North Africa is possibly responsible for the disjunction and differentiation of the forms involved.

The tables of contents and index are adequate for using the book. The bibliography is good, and includes several works of a general nature as well as titles directly or indirectly related to Moroccan amphibians. Several references are, however, given only in footnotes. The color plates of adults are satisfactory for the identification of the species, and the black and white figures make their points clear. A list of synonyms is given for the local forms, as well as notes on Arabic and Berber names. The authors regret that catalog numbers were not available for specimens in the collection of the Institute Scientifique Chérifien; such numbers are, however, being assigned.

As an introduction and status report on Moroccan amphibians, the present work achieves its ends remarkably well.—THOMAS M. UZZELL, JR., *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

EDITORIAL NOTES AND NEWS

A.S.I.H. Fiftieth

THE editors and the executive committee of the American Society of Ichthyologists and Herpetologists are planning to submit a request for support of the 1963 Fiftieth Anniversary Memorial Issue of *Copeia* and the 1963 meetings in Vancouver. We are particularly interested in travel expense for foreign

members. Schools interested in obtaining the services of foreign members for the semester preceding or semester following the meetings, and those willing to contribute support in exchange for seminar presentations, or similar services, should contact DR. C. L. HUBBS, Scripps Institution of Oceanography, La Jolla, Calif., so that we may be aware of all possibilities in obtaining foreign members for the meetings.

Copeia News

CUTS for the illustrations which have appeared in *Copeia* are returned to the Editor. Authors may obtain these cuts from the Editors by paying for the cost of packaging and mailing. (.50 per cut in advance). Requests for cuts of illustrations appearing in *Copeia* 1959 should be addressed to DR. PHILIP SMITH, *Illinois Natural History Survey, Urbana, Illinois*. Requests for cuts of illustrations appearing in *Copeia* 1960 should be addressed to D. L. JAMESON, *Department of Zoology, San Diego State, San Diego, California*.

Additional support for *Copeia* is available from the individual research grants of the membership. Some fund-granting organizations allow publication costs if they are approved as a part of the original research request. The following is quoted from *Grants and Scientific Research*, a bulletin of the National Science Foundation: "Publication Costs—Costs of preparing and publishing the results of the research conducted under the grant, such as reports, purchase of reprints, payment of page charges or other journal costs (except costs for prior or early publication), and necessary illustration costs should be *indicated*. These should be described and itemized in the research proposal." Note that the word "indicated" is used.

For grant research already in progress, it is often possible to transfer unused portions of a budget to provide for publication costs.

Such research funds will allow the more rapid publication of research in any outlet and will allow publication by *Copeia* of papers otherwise too long for acceptance.

Foreign News

THE recently established *Estación de Biología de los Llanos*, in Calabozo, Venezuela, welcomes visits from research scientists abroad. The station occupies about 480 acres of pasture land on the edge of the central valley of the Orinoco River. It was established by the Sociedad Venezolana de Ciencias Naturales of Caracas, chiefly through private contributions. The new center can furnish laboratories and general facilities for field work and for preliminary work on the preparation and preservation of specimens.

In addition to the research that may be carried out at the station itself, which has a typical tropical lagoon and palm grov interesting studies may be conducted in the area of the recently built Guarico Dam. There a new body of water, formed by the impounded Guarico River, has created conditions which provide an opportunity to observe changes in the plant and animal life of what was until recently a dry environment.

Only 5 hours by car or 1 hour by plane from Caracas, the Calabozo station offers excellent opportunities to the botanist, the zoologist, the ecologist, the pedologist, the geologist, and the physiologist to study the pasture lands of northern South America. Those who wish to conduct such tropical research will find that the station has comfortable lodgings. In addition to the station's facilities, visitors may make use of the facilities of the Universadad Central de Venezuela in Caracas, including the collections of the Instituto Botanica. For further information about the Estacion de Biologia de los Llanos, write by air mail to: PROF. A. BONAZZI, Correos del Este 4109, Caracas, Venezuela.

DR. GEOFFREY KESTEVEN, chief of the Biology Branch, Fisheries Division, of the Food and Agriculture Organization, has been appointed director of fisheries research in the Division of Fisheries and Oceanography of the Commonwealth Scientific and Industrial Research Organization at Cronulla, New South Wales. DR. KESTEVEN was responsible for the re-organization of the Biology Branch of FAO to its present form. The branch's work has attracted international attention and is widely appreciated by existing fisheries commissions, councils and other inter-governmental bodies for the service it is rendering. One of his notable contributions was the organization of the intelligence service which is widely used in fisheries biological matters and the initiation of the "Current Bibliography for Aquatic Sciences and Fisheries". DR. KESTEVEN first joined C.S.I.R.O. in 1939 as a junior research officer after two years with the New South Wales Fisheries Department. While still with that Organization, he was seconded to the office of the Commonwealth Controller of Fisheries in 1942, work with which he maintained association until 1947, when he joined the FAO as regional fisheries officer for the Far East. In 1952 he went to Rome as a member of the Biological Branch; he was appointed branch chief in 1954. MR. S. J. HOLT succeeds him as biology branch chief.

The tenth annual report of the *Nature Conservancy*, covering the year ending September 30, 1959, looks back over the Conservancy's first

decade of effort undismayed by the major defeat experienced during the year in the loss of the unique cuspate foreland and migration crossroads at Dungeness to the Central Electricity Generating Board for a nuclear power station.

A program of field and laboratory work to extend over the next few years includes a field study of the ecology of British reptiles, particularly their habitats, hibernation areas, behavior, predators and food, so that their conservation can be put on a more scientific basis. Initially the work, which is an integral part of the conservation program in the management plans of the Hartland and Morden National Nature Reserves in Dorset, is being confined to three species of snakes and to the sand lizard (*Lacerta agilis*).

DR. M. MEYER, Institute of Anatomy, University of Rostock, Rostock, Germany has requested specimens of bufonid and other anuran larvae for histological and cytological studies. Specimens should be fixed in Bouin's Solution.

DR. AUGUST THIENEMANN, renowned German limnologist known to ichthyologists chiefly for his extensive researches on the Coregonidae, died in Plon, West Germany, on April 22, 1960.

DR. CANUTO G. MANUEL has been appointed Commissioner of the National Institute of Science and Technology of the Philippines.

Expeditions

THE Sixth Archbold Expedition to New Guinea has returned to the *American Museum of Natural History* after 8 months of field research, which included the most extensive biological survey ever undertaken on Mount Wilhelm, highest mountain in eastern New Guinea. The return of LEONARD J. BRASS, associate curator in the museum's department of mammals and leader and botanist of the expedition, and Hobart M. Van Deusen, assistant curator and expedition mammalogist, preceded by a few days the arrival of 17 packing cases and crates containing approximately 76,000 animal and plant specimens collected in the Territory of New Guinea, northeast sector of the main island.

The total count of specimens is broken down as follows: 2295 mammals, 50 birds, 4105 amphibians and reptiles, about 50,000 insects and spiders, and 18,271 plants. In addition, approximately 1500 ectoparasites of mammals were collected for the research department of the Army Medical Service. The botanical specimens are being turned over to the United States National Herbarium in Washington for further study. The expedition, like its five predecessors in New Guinea and one in Australia, was sponsored by RICHARD ARCHBOLD, research associate of the museum and president of Archbold Expeditions, a nonprofit corporation affiliated with the museum.

Between 15 June and 23 August the University of California's *Scripps Institution of Oceanography* at La Jolla, Calif., sent the *SPENCER F. BAIRD* on an expedition to the central and equatorial Pacific area lying between Hawaii and the U. S. mainland. The purposes of this cruise were twofold, biological and geological. The cruise was divided into three phases. Phases 1 and 3 will be devoted to biology and hydrography; phase 2 is primarily geological. Sampling in phases 1 and 3 will consist of a series of deep mid-water trawls, opening-closing plankton tows, and hydrographic casts. Although the biological and hydrographic data collected will have a direct bearing on a number of studies now in progress, the primary biological objective of the expedition was to investigate the distribution and ecology of meso- and bathypelagic organisms. The distribution of epipelagic organisms is a reflection of the circulation patterns, and consequently several of these organisms have proved to be useful as indicators. There is good reason to believe that living forms at greater depths are adapted to a particular spectrum of physical conditions and that their occurrence is limited by these conditions. By extending knowledge of the distribution and abundance of these forms, it may be possible to find correlations with the properties of the deep water and the circulation pattern.

The scientific party included RICHARD H. ROSENBLATT, JOHN A. MACGOWAN, WILLIAM D. CLARKE, and DONALD M. DOCKINS of Scripps Institution, with DANIEL M. COHEN of the Fish & Wildlife Service as visiting participant.

Another Scripps expedition is scheduled for the period August 1960 to February 1961, when a research vessel will sail to the southwestern Pacific and southern Indian Ocean. The expedition, called Monsoon, will have a scientific program similar to those of the 1952–53 Capricorn and the 1957–58 Downwind investigations of the south and southeast Pacific, respectively.

Large-volume water sampling and radio-isotope and trace-element studies will be carried out, especially during the equatorial and southwestern Pacific portions of the trip. The biological program will consist of plankton sampling throughout the cruise and of mid-water trawls and dredging for benthic organisms in the southwest Pacific and the Indian Ocean. Monsoon's investigations of the southern and central Indian Ocean will provide reconnaissance of part of the basin prior to the large-scale, multi-nation co-

operative International Indian Ocean Expedition of 1960–64, proposed by SCOR. Monsoon will be Scripps Institution's initial contribution to that joint effort. About 18 marine scientists, chiefly from Scripps Institution, will be needed to carry out the basic program. Thus there will be room, and facilities, for several visiting scientists from other countries or laboratories. Suggestions for participation in the expedition are invited, and provision will be made for such participation in so far as time and ship's capacity permit.

The University of Michigan

IN the University the study of fishes is centered in the following units (with areas of special interest): Division of Fishes, Museum of Zoology (systematics, zoogeography, genetics); Department of Fisheries (fishery science and ecology, physiology and behavior); and Department of Zoology (natural history). Affilated with University effort are: Institute for Fisheries Research of the Michigan Department of Conservation, DR. GERALD P. COOPER, Director; Great Lakes [International] Fishery Commission, MR. NORMAN S. BALDWIN, Executive Secretary; and the Regional Office, U. S. Bureau of Commercial Fisheries, MR. W. F. CARBINE, Director, and its Great Lakes Fishery Laboratory, DR. J. W. MOFFETT, Chief.

In the Fish Division of the Museum of Zoology work in systematic ichthyology is being furthered by two grants from the National Science Foundation. REEVE M. BAILEY is investigating the phylogeny of spiny-rayed fishes through studies of comparative osteology and anatomy; he has been assisted by research associate C. LAVETT SMITH, who completed his doctoral study, a review of the American groupers, in 1959, and who accepted a teaching position at the Territorial College of Guam in August, 1960. DR. BAILEY is also working on a revision of the darters of the subgenus *Ulocentra* (genus *Etheostoma*). ROBERT R. MILLER is continuing the long-range studies of the biosystematics of viviparous fishes (chiefly *Poeciliopsis*) with the assistance of research associate R. JACK SCHULTZ, who obtained his Ph.D. in June, 1960, on the reproductive biology and genetics of certain species of *Poeciliopsis*. DR. MILLER is also working on the taxonomy of *Cyprinodon*, a popular book on Utah fishes, late Cenozoic fishes, and (with KARL F. LAGLER and JOHN E. BARDACH) a textbook of ichthyology. TERUYA UYENO (Zoology) completed his doctoral study on the osteology and phylogeny of the cyprinid genus *Gila* and its allies and has in press descriptions of fossil minnows from Plio-Pleistocene deposits in Idaho. He is expanding his work on American cyprinids, including fossils. CARTER R. GILBERT (Zoology), now studying Pacific sharks as a staff member of the Division of Fishes, U. S. National Museum, completed the doctorate "A Systematic and Geographical Study of the Subgenus *Luxilus* (Family Cyprinidae)" in June, 1960. HOWARD L. HUDDLE (Fisheries) is engaged in a doctoral investigation of behavioral aspects of certain species of *Poeciliopsis* as related to natural hybridization. JORGE CARRANZA (Fisheries), Director of the Marine Biological Station in Veracruz, plans to return to Ann Arbor in the fall to complete his doctoral thesis on the fish and fisheries of the Yucatan Peninsula. GERALD R. SMITH, appointed research assistant in the Museum of Zoology in September, 1959, has started a comparative osteological study of the Catostominae. CONRAD ISTOCK, appointed a teaching fellow (Zoology) at the same time, is currently studying the osteology of the percopsiform fishes. PROF. CARL E. BOND (Fisheries), on leave from Oregon State University during the year 1959–1960, is working on the ecology and systematics of western species of *Cottus*. THOMAS L. POULSON (Zoology) has nearly completed his doctoral thesis on cave adaptation in the Amblyopsidae, and JOHN P. KERR (Zoology) is investigating the role of learning in the group behavior patterns of certain tropical minnows.

In the Department of Fisheries, work on the biology of fishes is being advanced by National Science Foundation funds and by two University research grants. KARL F. LAGLER spent the summer teaching and studying the day-night changes in fish occupancy of selected habitats in Lake Erie at the Franz Theodore Stone Laboratory of Ohio State University. CARL GEORGE (Ph.D., Harvard, 1960) served as Research Assistant. DR. LAGLER is also reading proof on "Pêche Continentale," an extensive treatise on inland fisheries of the world written with RICHARD VIBERT, French Department of Waters and Forests. DR. LAGLER is also spending time on a text, "Ichthyology" (with DRS. BARDACH and MILLER). JOHN E. BARDACH continued his studies of reef fish coloration and ecology at Bimini last summer. During the past year work has emphasized neurosensory physiology of the skin of fishes. DRS. LAGLER and BARDACH have worked extensively on enlargement and development of facilities for the department; contracts have been let, work begun, and completion date set for September, 1962. The following master's theses were completed during 1960: ARNOLD ALBRECHT, "Growth of the largemouth bass in Park's Lake, Washtenaw County, Michigan;" VAUGHN C. ANTHONY, "Stream populations of young of the Atlantic salmon (*Salmo salar*) and other fishes in Maine;"

STANLEY M. DUSTIN, "The behavior of three species of fish towards the odor(s) of a commercial fish lure;" THOMAS A. EDSALL, "Age and growth of the whitefish of Munising Bay, Lake Superior;" GEORGE GREENE, "Size selectivity of Dieldrin on green sunfish, *Lepomis cyanellus*;" WILLIAM MCAFEE, "Redds of the red salmon, *Oncorhynchus nerka*, in three streams of the Alaska Peninsula;" ZIAD SHEHADEH, "The use of gonadotropins in forced spawning of fishes;" THOMAS WENKE, "Probable maximum age of native Michigan minnows, family Cyprinidae;" and ASA WRIGHT, "Age and growth of the Dolly Varden (*Salvelinus malma*) in a southeastern Alaskan estuary."

Doctoral investigations in progress (in addition to those of Bond, Huddle and Carranza given above) include: ABDUL AMIR AL SAADI (Iraqi Government Fellow), gerontology of the skeleton in *Micropterus*; GLENN A. FLITTNER, ecology in Lake Erie of *Notropis atherinoides* (supported by U. S. Bureau of Commercial Fisheries); JAMES E. HALL, life history of *Ichthyomyzon castaneus* (supported by Institute for Fisheries Research); ROJELIO JULIANO (Rockefeller Fellow), comparative anatomy of the swimbladder in Etheostomatinae; REMO RICIPUTI, microanatomy of fish scales. Professional summer employment found students in the far corners of the United States and Canada: KEMPINGER, Texas; ANTHONY and WENKE, Alaska; ALBRECHT, Oregon; MCLEOD, Ontario; RICIPUTI and DUSTIN, New Hampshire; MCAFEE, California; and EDSALL, Great Lakes.

The Saylor Awards for 1960 went to GLENN A. FLITTNER and GEORGE N. GREENE; the Greenberg Foundation Award in Fisheries went to JOHN M. GREEN.

Checklist Committee

AT the close of the 40th Annual Meeting of the Society in Chicago, President NORMAN HARTWEG appointed a committee to investigate the desirability of issuing a new checklist of North American amphibians and reptiles. The Committee members are HERNDON G. DOWLING, ALAN E. LEVITON, WILLIAM J. RIEMER, HOBART M. SMITH, RICHARD J. ZWEIFEL, and PHILIP W. SMITH, Chairman. DR. HARTWEG instructed the Committee to ascertain the support of the Society membership; to suggest the scope, content, and format of a new edition, if such is deemed desirable; and to determine the most economically feasible manner of producing a new checklist. The matter of a 7th edition of the checklist was briefly discussed at the Governors' Meeting in Chicago, and a recommendation was presented to the Governors by DR. ZWEIFEL that the Society consider replacing the standard, hardbound, single-author checklist with a loose-leaf edition, printed by good quality offset and bound in multi-ring binders. The spiral-bound book would contain sections prepared by appropriate specialists and could be revised piecemeal, as the need arose. Comments and suggestions by all herpetologists are invited by the Committee.

Awards

PRESENTATION of the National Academy of Sciences medals took place on 25 April, 1960, in Washington during the academy's 97th annual meeting. ANTON F. BRUUN, Zoological Museum of the University of Copenhagen, received the Agassiz Medal for original contribution in the science of oceanography.

ALFRED S. ROMER, Museum of Comparative Zoology at Harvard College, received the Daniel Giraud Elliot Medal, given for the most meritorious work in zoology or paleontology published each year.

JOHN A. MOORE, Columbia University, was elected a fellow by the American Academy of Arts and Sciences at its 180th annual meeting on 11 May, 1960.

JEAN ROSTRAND, the well-known French biologist and student of frogs and toads, was awarded the 1959 Kalinga Prize for "outstanding contributions to the dissemination of scientific knowledge to the general public," 21 April 1960.

Journal News

THE new JOURNAL OF THE MARINE BIOLOGICAL ASSOCIATION OF INDIA, Volume 1, Number 1, June 1959, contains several papers of interest to ichthyologists. It is published by the Marine Biological Association of India, Marine Fisheries P. O., Mandapam Camp, Ramnad, South India, and is issued half-yearly in June and December. Membership subscription for individuals who qualify is Rs. 12.50 plus an entrance fee of Rs. 5/—, (Rs. 17.50 = ca. $3.75); institutional subscription is Rs. 20/— (= $4.25). Foreign checks should include 50¢ toward bank charges. The *Journal* is not available on exchange basis. Further information may be obtained from The Secretary at the address given above.

REPHIBIA, Journal of the Metropolitan New York Herpetological Society became a quarterly publication starting with the fall 1960 edition. Rephibia is a non-technical digest devoted to the conservation, scientific and cultural aspects of reptile-amphibian study. The subscription price is $4. per annum; P. O. Box 71, Brooklyn 9, New

York. The officers of the Metropolitan New York Herpetological Society for 1960–1961 are: President CHARLES W. HECKMAN; Vice-President, GEORGE MEYER; Treasurer, HAROLD SWANSON; Secretary, LUCY EHRLICH; Editor, JOHN BURKE GILLESPIE.

The CURRENT BIBLIOGRAPHY FOR AQUATIC SCIENCES AND FISHERIES, formerly issued by the Fisheries Biology Branch of the FAO in Rome in a mimeographed form, is now obtainable only in the new printed form by subscription directly to Messrs. Taylor and Francis, Red Lion Court, London, E. C. 4, England, or to their agents overseas. Many issues of the mimeographed versions of Volumes 1 and 2 are now out of stock, but requests to FAO, Viale delle Terma di Caracalla, Rome, Italy, will continue to be met while stocks last. These volumes are distributed free. S. J. HOLT, Chief, Fisheries Biology Branch, stated recently that if there is sufficient demand, it may eventually be possible to re-run the mimeographed issues, so that new subscribers to the printed version will have available to them complete bibliographic lists and indexes of publications from 1957.

The periodical PESCA Y CAZA, official publication of the Peruvian Ministry of Agriculture, Division of Fishing and Hunting, is now distributed by subscription only by the Libreria Internacional del Peru, S. A. Subscriptions ($4.80 for 4 issues annually) may be entered with the above agency in Lima, Peru.

41st Annual Meeting of ASIH

THE American Society of Ichthyologists and Herpetologists will hold its forty-first annual meeting on the campus of The University of Texas, Austin, from March 31 to April 3, 1961. Hotel headquarters will be at the Villa Capri Motor Hotel at 2360 Interregional Highway. This hotel is only two miles from the airport and is within walking distance of the campus. Requests for reservations should be sent to the manager of the Villa Capri.

All titles of papers and requirements for their presentation must be received prior to February 1, 1961. All those having papers suitable for presentation as demonstrations are urged to submit them as demonstration papers, as they will thus receive much more attention than from being read in the brief time available on the technical sessions. Send titles to: W. Frank Blair, P.O. Box 7536, Univ. Station, Austin 12, Texas.

Tentative Program

Thursday 30 March
  Board of Governors Meeting, 8:00
Friday 31 March
  AM—Joint Session—Contributed Papers
  Noon—Group Photograph
  PM—Concurrent Sessions—Contributed Papers
  Evening—Open House and Texas Herpetological Society Exhibit
Saturday 1 April
  AM and PM—Field Trips
  Noon—Joint Lunch
Sunday 2 April
  AM—Symposium: "Physiological Ecology of Heterothermal Vertebrates"
    The tentative list of speakers includes: W. R. Dawson, A. D. Hasler, F. Munz and P. F. Scholander, F. E. J. Fry
  PM—Concurrent Sessions—Contributed Papers
  Evening—Annual Dinner
Monday 3 April
  Field Trips to Gulf of Mexico, Laguna Madre, Matagorda Island, and Gulf Coastal area. (Those traveling by air or train and taking the Monday trip may arrange return reservations from Corpus Christi).

News Notes

A PACIFIC Scientific Information Center has been established at the Bishop Museum, Honolulu, with the aid of a grant from the National Science Foundation. The purpose of the center is to further the interchange of information concerning the geography and natural history of Pacific islands, especially information dealing with the land flora and fauna and with man in his relationship to his environment.

ALBERT G. SMITH, Major, USAFR, has been recently assigned as Consultant in Aerospace Navigation to the USAF Aeronautical Chart and Information Center in St. Louis. His wife, DR. ELLEN SMITH was also recently appointed as Research Assistant Professor in Pharmacology at the Washington University School of Medicine in St. Louis.

DR. ROBERT RUSH MILLER, one of the curators of fishes at the University of Michigan Museum of Zoology, has been promoted to the position of Professor of Zoology, which title he will hold concurrently with that of Curator.

DR. JAMES E. MORROW, JR., of the Bingham Oceanographic Laboratory of Yale University, has been appointed to the position of Fisheries Management Biologist at the University of Alaska.

DR. ALFRED W. EBELING, who has recently received his Ph.D. in the University of California, with a thesis on the Melamphaidae, has been appointed instructor in the Zoology Department, and Curator of Fishes in the Peabody Museum

at Yale University. He will be associated also with the Bingham Oceanographic Laboratory.

ROY CHAPMAN ANDREWS, Carmel, California; 76, explorer and naturalist; former director of the American Museum of Natural History; first discoverer of dinosaur eggs in the Gobi Desert; died March 11, 1960.

As this issue goes to press, two recent deaths are reported: DR. WILLIAM M. MANN, Director Emeritus of the National Zoological Park, Washington, D. C., and MISS MARGARET H. STOREY, Assistant Curator of Zoological Collections, Natural History Museum, Stanford University, California.

SUMMARY OF 1960 MEETING

THE fortieth annual meeting of the American Society of Ichthyologists and Herpetologists was held at the Chicago Natural History Museum, Chicago, Illinois, from June 17 to 19, inclusive. The Board of Governors held its annual meeting during the evening of June 16. The Local Committee consisted of ROBERT F. INGER, Chairman, WILLIAM BRAKER, D. DWIGHT DAVIS, TOM DOLAN, MARION GREY, HYMEN MARX, R. MARLIN PERKINS, CLIFFORD H. POPE, GEORGE B. RABB, ROBERT SNEDIGAR, PEARL SONODA, LOREN P. WOODS, and JANET WRIGHT.

EVENTS OF THURSDAY, JUNE 16

The annual meeting of the Board of Governors was convened at 7:45 PM in the Bel-Air Room of the Conrad Hilton Hotel with fifty governors and many members and guests in attendance. President NORMAN E. HARTWEG was in the chair.

The Secretary read messages of regret for absence from the following members of the Society: RICHARD J. BALDAUF, JOHN C. BRIGGS, DANIEL M. COHEN, WILLIAM E. DUELLMAN, HOWARD K. GLOYD, COLEMAN J. GOIN, EARL S. HERALD, RICHARD M. JOHNSON, JAMES A. OLIVER, and NORMAN J. WILIMOVSKY.

The minutes of the 1959 meeting, held in San Diego, were approved as published in *Copeia, 1959 (4):355–364*.

A sum of 75 pounds was contributed toward the publication of the Zoological Record.

It was decided to accept an invitation from the University of British Columbia to meet during June of 1963 in Vancouver. The Governors were reminded that the 50th anniversary of the Society will be celebrated during 1963 and that any special event commemorating the occasion will probably occur during the Vancouver meeting. Dr. M. GRAHAM NETTING, Chairman of the Committee on the 50th anniversary, reviewed some of the suggestions for special activities that had been made to his committee.

The report of GILES W. MEAD, Vice-President for Finance, was discussed, and the recommendation was made and heartily endorsed that both the Treasurer and the Publications Secretary should place a sizable portion of the money collected through their offices in savings accounts or short-term government bonds in order to earn interest. To effect a plan to assure the Society of future income, the following resolution was offered jointly by the Vice-President for Finance, the Treasurer, and the Secretary:

Resolve that:

(1) The words "during the lifetime of the Member" in Article I, Section 2, of the By-laws be deleted, so that this section will read as follows:

> "Section 2. Life Members may pay their dues in one lump sum or in annual installments of $25. each. All sums paid by Life Members shall be kept in a separate account, the Endowment Fund."

and (2) Section 3 of Article 8 of the By-laws be replaced by the following paragraph:

> "Section 3. The Endowment Fund shall consist of the proceeds from the sale of Life and Patron Memberships, gifts or bequests to the Society if so specified by the donor, and receipts from the sale of back issues of *Copeia* and of other Society publications. The principal of this Fund must be kept intact, and the interest credited, as received, to the current operating account of the Society."

This resolution to amend the By-Laws was passed by the Governors with only one dissenting voice.

DR. ROYAL D. SUTTKUS, Vice-President for

Membership, reported that a letter is soon to be sent to delinquent members and subscribers, which it is expected will result in a reinstatement of a number of names. The suggestion was made by DR. GEORGE B. RABB that a membership application blank should be included this autumn when the new Secretary sends dues notices to all members and subscribers. It is hoped that such applications will serve to enroll students or other persons as new members.

During discussion of the report of the Managing Editor, DR. DAVID L. JAMESON, pointed out that *Copeia* has only a small backlog of manuscripts, and he urged the Governors to submit their papers to our journal. The possibility of paying the editors' ways to the annual meetings was discussed, and the thought was developed that there are no fewer than six working officers of the Society who might equally be considered for the same privilege. The opinion was expressed that attempting to meet such an array of travel expenses would be beyond the financial means of the Society. As a matter of information, the Society's By-Laws have long provided for the payment of the Secretary's expenses. It was decided that since the expenses of most officers are paid by their respective institutions, no formal change should be made in the By-Laws. It was understood, however, that, should the necessity arise, money for travel might be provided by ASIH upon application, if the treasury were in the proper condition to make such an expenditure possible. It was decided by majority vote that any papers of merit should be considered for publication in *Copeia* whether the author was a member of ASIH or not, but that all such non-member contributors should be invited to join the Society. DR. JAMESON announced that all manuscripts should now be submitted to the sectional editors instead of being forwarded directly to his office.

The Publications Secretary, DR. N. BAYARD GREEN, reported that back issues of *Copeia* and other publications had been sold during 1959 in the amount of $1540.44. The question of reprinting some of the back issues that no longer are available was considered, and the Governors voted to expend a sum of $300 to $400 annually for this purpose, at the discretion of the Publications Secretary and the Executive Committee. DR. CARL L. HUBBS stated that he would investigate the possibility of seeking help from the National Science Foundation to reprint some of the issues of *Copeia* that no longer are in stock.

DR. REEVE M. BAILEY read a letter from Past-President GEORGE S. MYERS suggesting that ASIH supply Berlin scientists with back issues of *Copeia*. Several of the Governors volunteered to make duplicate copies available for this purpose.

The report of Treasurer JAMES E. BÖHLKE, which is appended immediately below, indicated that the ASIH is in sounder financial condition than at any time in the past. Nearly $10,000 had been invested during 1959 and a balance of $6301.97 remained at hand at the end of the year after all expenses had been paid.

The auditing committee, of which EDMOND V. MALNATE is Chairman, commended DR. BÖHLKE on his stewardship of the Society's funds, and strongly urged that the duties of the Secretary and Treasurer be re-distributed to place more work and responsibility in the hands of the Treasurer.

Financial Report for Calendar Year 1959

CHECKING ACCOUNT

Balance on hand, Central-Penn National Bank, Philadelphia, January 1, 1959		$12,372.01

RECEIPTS

Memberships		7,901.50
Subscriptions		5,033.00
Sale of Publications by Publications Secretary		1,775.35
Sale of *Copeia* by Secretary		9.60
Sale of Check List		10.75
Sale of Common Names Check List		6.00
Interest from Government bonds		248.00
Sale of *Copeia* mailing lists		40.00
Payment for a reengraving at an author's request		8.20
Central-Penn National Bank-credit memos		2.16
Contributions		
Paul K. Anderson (Revolving Research Fund)	175.00	
William J. Riemer (Revolving Research Fund)	50.00	
Alice G. C. Grandison (K. P. Schmidt Fund)	5.00	
Thomas H. Lewis (K. P. Schmidt Fund)	5.00	
Carleton Ray (K. P. Schmidt Fund)	5.00	
J. C. Battersby (K. P. Schmidt Fund)	5.00	
Loren P. Woods (K. P. Schmidt Fund)	5.00	
J. A. Tubb (K. P. Schmidt Fund)	10.00	
Werner H. Gottsch (K. P. Schmidt Fund)	10.00	
W. E. B. Hall (K. P. Schmidt Fund)	10.00	
James W. Atz (K. P. Schmidt Fund)	10.00	
Ross Allen's Reptile Inst. (K. P. Schmidt Fund)	10.00	
W. K. Gregory (K. P. Schmidt Fund)	5.00	
G. S. Myers (K. P. Schmidt Fund)	10.00	
Miscellaneous (K. P. Schmidt Fund)	16.00	
		331.00
Subtotal (receipts)		15,365.56
Total		27,737.57

EXPENDITURES AND DISBURSEMENTS

Publication of *Copeia*		
1958, no. 4	$2748.38	
1959, no. 1	1963.24	
1959, no. 2	2126.29	
1959, no. 3	1920.29	
		8758.20
Dues, A.I.B.S.		848.00
Transportation of editorial files		12.34
Editor's trip to New Orleans for transfer of job		93.80
Stenographic services—San Diego		25.00
Secretarial services—Philadelphia		150.00
Secretarial services—Editor		601.00
Printing		522.31
Postage		
Secretary	191.84	
Editor	62.25	
		254.09
Phone calls		
Secretary	27.76	
Treasurer	5.67	
		33.43
Telegrams—Editor		12.53
Supplies—Secretary		29.90
Refunds of dues paid in excess		24.50
Bank charges		.60
Purchase of 134 shares of Mass. Investor's Trust		1989.90
Transfer of funds to Savings for interest		5000.00
Purchase of 3—$1000 government bonds		3000.00
Student Prizes		
Stoye		
Alfred W. Ebeling (1st prize, Ichthyology)	25.00	
Bruce B. Collette (2nd prize, Ichthyology)	15.00	
James D. Anderson (1st prize, Herpetology)	25.00	
Velma J. Vance (2nd prize, Herpetology)	15.00	
		80.00
Total Expenditures		21,435.60
Balance on hand, December 31, 1959		
Central-Penn National Bank, Philadelphia		6301.97
Total		27,737.57

ENDOWMENT FUND

Balance on hand, January 1, 1959	
Second Federal Savings and Loan, Philadelphia	$3989.05
Received from life members	950.00
Transferred from checking account	5000.00
Interest	299.99
Total	10,239.04
Balance on hand, December 31, 1959	
Second Federal Savings and Loan, Philadelphia	10,239.04

REVOLVING RESEARCH FUND

(A part of the general checking account)

Balance on hand, January 1, 1959	
Central-Penn National Bank, Philadelphia	340.25
Received from Paul K. Anderson	175.00
Received from William J. Riemer	50.00
Total	565.25
Balance on hand, December 31, 1959	
Central-Penn National Bank, Philadelphia	565.25

The Secretary summarized the customary statistics, indicating that, as of June 1, 1960, the Society's roster could be broken down as follows: 721 regular members, 182 student members, 68 foreign members, 115 life members, of whom 90 are paid in full, 29 free copies, of which most go to our Honorary Foreign Members, and 472 subscribers, making a total mailing list of 1587. In addition, on the same date, there were 102 members and 22 subscribers who were in arrears and many of whom might be expected to pay soon. Our roster at present is nearly the same in total number as it was last year. In accordance with instructions from the Executive Committee application for the trademark registration of the name *Copeia* had been made.

The Secretary then presented a review of current practices, tracing in some detail the history of why the great bulk of the clerical chores has been done by the Secretary's office for decades. He pointed out that much of the work consists of collecting and posting dues payments and taking care of a multitude of details that could be handled readily and efficiently by a person trained in clerical work, and that it was wasteful for a scientist to be obliged to devote his attention to such chores. In the past these duties have been undertaken in large part by the wives of the various secretaries. He strongly urged that the Society make provision to hire someone to do such work to relieve the Secretary and/or Treasurer. With the cooperation and consent of the Executive Committee he had investigated such a possibility, and had attempted to obtain prices from a business firm in Philadelphia, another in Baltimore, and from the AIBS. Only the AIBS would offer a firm price. He recommended that for this and other reasons the Society subscribe to the AIBS business management service for a trial period of one year.

Upon request, GILES MEAD read a letter from DR. DANIEL M. COHEN in which he (COHEN) urged that our Society also subscribe to the AIBS redactory service to give assistance to our editors.

A lively discussion then followed. MR. FRANCIS HARWOOD, of AIBS, spoke about the services offered by his office. Several Governors spoke in favor of AIBS, whereas others were strongly opposed. One of our officers felt that he would be compelled to resign if he were required to work with AIBS. So also did two other Governors who had offered to serve as officers if nominated and elected. At this point a vote was taken, and a motion to subscribe to the AIBS services was rejected by 26 to 18. A motion to provide clerical help to the new Secretary and/or Treasurer in

the amount of $1000 for the year 1961 was approved.

The reports of the Western and Southeastern Divisions of the Society were approved. The question of financial support for these Divisions was discussed, and the Secretary explained that it had been customary to supply each Division annually with a set of stamped envelopes addressed to their own divisional members for the purpose of mailing notices of meetings. A motion that the Western and Southeastern Divisions be abolished was voted down.

MR. CONANT, as a member of the Committee on Traffic in Venomous Snakes, reported for the chairman, DR. JAMES A. OLIVER, as follows: Members of the Committee and of a similar Committee of the American Association of Zoological Parks and Aquariums were invited to attend a Congressional hearing in Washington on June 6, 1960, on House Resolution No. 10598. This bill would give the Secretary of the Interior stand-by power to prohibit the importation of any animal which, in his opinion, was inimical to the public welfare. The bill also provided, however, that the Secretary of the Interior would be empowered, where there was evidence of responsibility, to issue permits for the importation of any such animals for zoological, educational, medical, and scientific purposes. Since it has long been feared that a fatality from the bite of an exotic poisonous snake might stampede the Congress into passing crash legislation that might prohibit the importation of *all* snakes, the representatives of the committees of the two organizations testified in favor of the bill.

The report of the committee to investigate the translation of biological literature, of which DR. DONALD P. DESYLVA is chairman, was tabled.

The following persons were elected Governors to serve in the Class of 1965: JAMES E. BÖHLKE, ROGER CONANT, HERNDON G. DOWLING, JOHN D. KILBY, SHERMAN A. MINTON, JR., JAMES A. OLIVER, DONN E. ROSEN, W. B. SCOTT, ROYAL D. SUTTKUS, and JOE TIHEN. E. PETER VOLPE was elected to fill a vacancy in the Class of 1962.

Dr. Philip W. Smith presented a summary of comments from herpetologists on a proposed seventh edition of the check list of North American amphibians and reptiles. There were numerous opinions, but the concensus was that preparation should be made of a seventh edition or that a supplement, to be called a seventh edition, be made to the current sixth edition. Several ichthyologists suggested that the time might soon be ripe for the preparation and publication of a fish check list. After discussion the matter of the herp check list was referred to the President and the Executive Committee for action.

[Subsequent to the meetings, President HARTWEG appointed the following persons to serve as a Committee on a North American herpetological checklist: PHILIP W. SMITH, Chairman, HERNDON G. DOWLING, ALAN E. LEVITON, WILLIAM J. RIEMER, HOBART M. SMITH, and RICHARD G. ZWEIFEL.]

DR. JAMES A. PETERS suggested that the Society express its interest in an organization of Latin American ichthyologists and herpetologists that is now being formulated. It was voted that the President be authorized to communicate our interest to our Latin American colleagues.

DR. EDWARD C. RANEY proposed the following amendment to the Society's Constitution: Resolved that a new Section 4 be added to "Article III: Membership" as follows:

a. Distinguished Fellows shall be elected by the Board of Governors from among North American members of the Society who have attained distinction as investigators and/or have made noteworthy contributions to the Society.
b. Nominees for Distinguished Fellows shall have been a member of the Society for a period of 20 years or more.
c. The number of Distinguished Fellows shall not exceed 20 at any one time and not more than six shall be elected in any one year. They shall be equally divided among Ichthyologists and Herpetologists.
d. Distinguished Fellows shall be nominated by petition which shall be signed by 10 or more members of the Society. This petition shall list the scientific achievements and services rendered by the nominee. The petition shall be addressed to the Secretary at least two months before the annual meeting.
e. Distinguished Fellows shall be listed on the back cover of *Copeia*.

This resolution was passed by the necessary two-thirds majority.

A suggestion that dues to foreign members be increased by one dollar per year, so that they may be sent the AIBS bulletin, was voted down.

The question of whether the Governors of the Society should be selected on some other basis than at present was raised, but it was agreed to refer this to a special committee to be appointed by the President with instructions to report at the next annual meeting. It was also agreed to refer to the same special committee the subjects of whether the Constitution and By-Laws should be amended to spell out the names, make-up, and duties of standing committees, and whether provision should be made for financial assistance to the Society's Western and South-

eastern Divisions. [Subsequent to the meetings President HARTWEG appointed the following persons to serve as special committee on the Constitution and By-Laws of the Society, and he charged them with consideration of the three points enumerated in the paragraph above: W. I. FOLLETT, Chairman, WILLIAM M. CLAY, HENRY S. FITCH, GEORGE B. RABB, and W. B. SCOTT.]

The Board of Governors meeting was adjourned at 1:00 A. M.

EVENTS OF FRIDAY, JUNE 17

The delegates to the meeting assembled in joint session in the ground floor lecture hall of the Chicago Natural History Museum where they received an address of welcome from MR. E. LELAND WEBBER, Assistant Director of the Museum. President NORMAN E. HARTWEG responded on behalf of the Society and presided while the following papers were given:

A Preliminary Analysis of Locomotion in Sea Turtles. Warren F. Walker, Jr., Oberlin College.

Gynogenesis in the Teleost *Poecilia formosa*, and the Detection of Parthenogenesis in Vertebrates by Tissue Transplantation. Klaus D. Kallman, Genetics Laboratory, New York Aquarium.

Uniparental Reproduction in *Gambusia affinis*. John D. Kilby, University of Florida, and Klaus D. Kallman, Genetics Laboratory, New York Aquarium.

After a brief intermission DR. ERNEST A. LACHNER assumed the chair and presided while the following papers were given:

Type Locality Restrictions in Nomenclatorial Procedure. James A. Peters, San Fernando Valley State College.

The Worldwide Occurrence of Commensalism Between Young Fishes and Scyphomedusans. Romeo Mansueti, Chesapeake Biological Laboratory.

The Advantages of Obscurity in Research Work. William A. Gosline, University of Hawaii.

A Toad-flounder-salmon Association in Coastal Alaska. Ernest L. Karlstrom, Augustana College.

At the conclusion of the morning session members and their spouses assembled on the steps on the south side of the Museum for the taking of the annual group picture. During the afternoon the ichthyologists met in the auditorium of the Shedd Aquarium where, with WILLIAM BRAKER presiding, the following papers were heard:

Experiments on Schooling of *Randomichthys asocialis*, *Colisa lalia*, and Other Species. George C. Williams, Michigan State University.

Aggressive Behavior and Dominance in Large-Mouth Bass. Richard Stein, Adelphi College.

Some Aspects of Swimming Behavior in Characin Fishes. Vladimir Walters, American Museum of Natural History.

The Breeding Behavior of the Shielded Darter, *Percina peltata*. John G. New, New York State University College of Education.

A Technique for Fish Photography. John E. Randall, University of Miami.

The Technique of Anesthetizing and Operating on Large Sharks. Perry W. Gilbert, Cornell University.

Collecting Specimens for the Vancouver Public Aquarium. Murray A. Newman, Vancouver Public Aquarium.

Tests of the Efficiency of Sand and Gravel Filters for Aquariums. Robert P. Dempster, Steinhart Aquarium, California Academy of Sciences.

The Spawning and Early Development of the Parrotfish, *Sparisoma rubripinnis*, John E. Randall and Helen A. Randall, University of Miami.

Observations on the Behavior of Young Gars (*Lepisosteus*). George A. Moore and Carl D. Riggs, Oklahoma Agricultural and Mechanical College and University of Oklahoma.

The New National Fish Hatchery Aquarium at Welaka, Florida. Craig Phillips, National Aquarium, Washington, D. C.

Aggressive Behavior in Some Species of Lionfish (*Pterois*). R. M. Segedi, Cleveland Aquarium.

An Aquarium Exhibit With Polarized Light. W. E. Kelley, Cleveland Aquarium.

Meanwhile the herpetologists, finding themselves confronted with a great variety of papers, were forced to conduct two separate and concurrent sessions. CHARLES M. BOGERT presided at one session where the following papers were given:

Biosystematic Studies on Toads of the *Bufo boreas* Group. Jay M. Savage, University of Southern California.

Observations on Teiid Lizards in Southern Brazil. William W. Milstead, University of Kansas City.

Evidence for Natural Hybridization between *Desmognathus f. fuscus* and *Desmognathus o. ochrophaeus*. Jeanne Jones, Adelphi College.

Relationships in the Salamander Genus *Aneides*. David B. Wake, University of Southern California.

The Courtship Pattern of the Mole Salamander, *Ambystoma talpoideum*. C. Robert Shoop, Tulane University.

Preliminary Studies on Turtles in the Upper Rio Grande Drainage. John M. Legler, University of Utah.

Comments on the Life History of the Wood Turtle, *Clemmys insculpta*. John G. New, New York State University College of Education.

Additional Information on Frogs of the *Hyla versicolor* Complex. Clifford Johnson, University of Texas.

The Significance of Call Variation in the *Pseudacris nigrita* Complex. M. J. Fouquette, Jr., University of Florida.

Vocal Variation in Two Species of Chorus Frogs (*Pseudacris*) in Texas. Ted C. Michaud, Carroll College.

Congo Frog Calls. Robert F. Inger, Chicago Natural History Museum.

The second herpetological section met under the chairmanship of DR. RICHARD A. EDGREN, and the papers listed below were heard.

Thermal Relations of Five Species of *Anolis*. Rodolfo Ruibal, University of California, Riverside.

Seasonal and Geographical Variation in the Critical Thermal Maxima of Salamanders. Victor H. Hutchison, University of Rhode Island.

Survival Rate in Anurans. Frederick B. Turner, Wayne State University.

Thermal Acclimation in Amphibians. Bayard H. Brattstrom and Penny Lawrence, Adelphi College.

Thermal Characteristics of Some Baja Californian Lizards. Michael E. Soulé, Stanford University.

Variables Affecting Heat-gain in Turtles. Judith Hardy, Adelphi College.

The Laboratory Determined Activity Cycle of the Garter Snake, *Thamnophis radix*. Carlton Heckrotte, Eastern Kentucky State College.

Morphological Responses of Some Ozark Plethodontids to Iodinated Amino Compounds. Harold A. Dundee, Tulane University.

Studies on Nitrogen Excretion in the Adult Salamanders *Ambystoma jeffersonianum* and *Ambystoma maculatum*. J. W. Wacasey, Michigan State University.

Hormonal Replacement of Photoperiod as a Stimulus for Growth in *Anolis carolinensis*. Anthony DiMaggio III, Louisana State University School of Medicine.

Case Report of a Bite by a Red Diamond Rattlesnake, *Crotalus r. ruber*. Gary K. Clarke, Midwest Research Institute, Kansas City.

Morphological and Behavioral Factors Associated with Water Uptake in Treefrogs. Gladys Hynek and Bayard H. Brattstrom, Adelphi College.

During the evening members and their guests visited the Lincoln Park Zoo under the guidance of R. MARLIN PERKINS, Director, and members of his staff. They were given refreshments and a special tour of the reptile house, and they also visited the lion house and the new indoor Children's Zoo.

EVENTS OF SATURDAY, JUNE 18

Members again met in joint session, with President NORMAN E. HARTWEG presiding, and heard the following papers:

Differentiation of the Toads *Bufo valliceps*, *Bufo fowleri*, and Their Natural Hybrids by Electrophoresis of Blood Proteins. Herbert C. Dessauer, Wade Fox, and Peter Volpe, Louisiana State University School of Medicine and Newcomb College, Tulane University.

Orientation Mechanisms in the Lamprey *Petromyzon marinus*. H. Kleerekoper, McMaster University.

The Structure and Photomechanical Responses of the Chameleon Retina. M. A. Ali, Memorial University of Newfoundland.

After a brief intermission President HARTWEG called the annual business meeting to order. The President asked Secretary CONANT to present a summary of the Board of Governors meeting which had been held the previous Thursday evening. In conjunction with the summary a vote was taken on the two amendments (given in detail above). The first of these, the amendment of the By-laws calling for an investment program of certain funds received by the Society, was approved unanimously. The amendment to the Constitution providing for Distinguished Fellows was passed by more than the necessary two-thirds majority.

DR. REEVE M. BAILEY, immediate Past-President of ASIH, stated that he had written letters inviting our Honorary Foreign members to attend the Chicago meetings of the Society. Although none of them had come, many had shown interest, and he recommended that the practice of inviting them several months in advance should be continued. He called attention to the fact, however, that the Board of Governors had indicated at a previous meeting that no financial aid should be offered from the treasury of ASIH.

DR. REEVE M. BAILEY reported as chairman of the Society's committee on common names for fishes. He stated that with the support of the National Science Foundation, which had subscribed $4,775, the report of his committee was currently in press, the said committee being a joint one consisting of the same members and representing the American Fisheries Society as well as ASIH. The terms of the grant from NSF required that all proceeds from the sale of the publication for the first three years be returned to NSF. Printing was done by Waverly Press, and a total of 6000 copies have been struck off, some 600 of which are being bound. Paper-covered copies cost one dollar each and bound copies, two dollars each. They may be purchased by writing to DR. E. A. SEAMAN, Secretary and Treasurer, American Fisheries Society, Box 483, McLean, Virginia.

MR. ROGER CONANT reported for the Committee on Herpetological Common Names. He stated that, although the committee is serving solely on a stand-by basis, an attempt had been made to determine the acceptance that had been accorded to the committee's report and which had been published in *Copeia* in 1956. It has been found that zoological gardens and natural history museums in general, and amateur herpetological groups were making a definite effort to follow the committee's list, and that many faunal papers published recently and certain handbooks had followed it meticulously. He also pointed out, however, that there were inconsistencies in the current issue of *Copeia* in the use of herpetological common names, and that certain authors of papers who are unfamiliar with the list or those who have been unsympathetic with the work of the committee or its recommendations have gone their own separate ways. In summary, it appears that persons in organizations required to work with the public and those who believe that standardization is desirable are finding the committee's list useful. The committee will continue to work toward standardization and will concentrate some of its effort upon bringing the list to the attention of herpetologists who may have forgotten about it or who may be unaware of its existence.

The Secretary read a memorandum from MR. WILLIAM H. STICKEL calling attention to the need

for research into the effects of pest-control spray campaigns upon cold-blooded vertebrates. He urged academic personnel, who are searching for research problems for students, to consider the possibility of assigning a project that would be helpful in evaluating the results of such spraying.

MAJOR HUGH L. KEEGAN, of the Army Medical Service School, Fort Sam Houston, Texas, made an announcement about the symposium on "Venomous and Poisonous Animals, Poisonous and Noxious Plants of the Pacific area" that will be convened at the Tenth Pacific Science Congress in Honolulu, Hawaii, from August 21 to September 9, inclusive, during 1961. Local hosts and co-sponsors will be the Bishop Museum and the University of Hawaii. MAJOR KEEGAN urged members of ASIH, who are in a position to make contributions, to prepare papers for presentation at the symposium.

The Nominating Committee consisting of DR. EDWARD C. RANEY, Chairman, and the DRS. WILLIAM M. CLAY, EARL S. HERALD, ROBERT C. STEBBINS, and CHARLES F. WALKER placed the following names in nomination:

President: GEORGE A. MOORE (who advanced from President-Elect)

President-Elect: ROGER CONANT

Vice-President for Conservation: NEIL D. RICHMOND

Vice-President for Finance: ROBERT RUSH MILLER

Vice-President for Membership: DORIS M. COCHRAN

Treasurer: JAY M. SAVAGE

Secretary: JAMES A. PETERS

Publications Secretary: N. BAYARD GREEN

Managing Editor: DAVID L. JAMESON

Ichthyological Editor: ROMEO MANSUETI

Herpetological Editor: ROBERT F. INGER

Index Editor: RONALD W. CRAWFORD

Editorial Board:

Ichthyologists: ROLF L. BOLIN, ROBERT W. HARRINGTON, JR., ERNEST A. LACHNER, ROBERT R. MILLER, and EDWARD C. RANEY.

Herpetologists: HENRY S. FITCH, WADE FOX, CLIFFORD H. POPE, GEORGE B. RABB, and ERNEST E. WILLIAMS.

There being no further nominations from the floor, the above persons were elected unanimously.

President HARTWEG appointed the following committees to serve during the year 1961:

Nominating Committee: KENNETH S. NORRIS, Chairman, WILLIAM J. RIEMER, ALAN E. LEVITON, C. RICHARD ROBINS, and BOYD W. WALKER.

Common Names of Fishes: REEVE M. BAILEY, Chairman, ERNEST A. LACHNER, CASIMIR C. LINDSEY, C. RICHARD ROBINS, PHILIP M. ROEDEL, W. B. SCOTT, and LOREN P. WOODS.

Herpetological Common Names: ROGER CONANT, Chairman.

Committee to Investigate the Translation of Biological Literature: VLADIMIR WALTERS, Chairman, DONALD P. DESYLVA, CARL GANS, ROBERT P. DEMPSTER, and TERUYA UYENO.

Committee on Traffic in Venomous Snakes: HERNDON G. DOWLING, Chairman, ROGER CONANT, SHERMAN A. MINTON, JR., CHARLES E. SHAW, and GEORGE B. RABB.

Local Committee for Austin Meeting: W. FRANK BLAIR, Chairman.

Committee on Zoological Nomenclature: GILES W. MEAD, Chairman, SHERMAN BLEAKNEY, ROYAL D. SUTTKUS, CLARK HUBBS, BAYARD BRATTSTROM, and HOBART M. SMITH.

Special Committee for the 50th Anniversary: M. GRAHAM NETTING, Chairman, HELEN T. GAIGE, COLEMAN J. GOIN, and CARL L. HUBBS, and the Managing Editor of *Copeia*, the Secretary of ASIH, and the Treasurer of ASIH.

President HARTWEG announced that he had received a letter of resignation from DR. ERNEST A. LACHNER as the ASIH representative to the governing board of AIBS and which he was accepting with regret. He announced and he was appointing DR. RICHARD G. ZWEIFEL to the post to serve out the unexpired term which ends on December 31, 1961.

Immediately following the business meeting members and their families boarded buses which took them to the Chicago Zoological Park in Brookfield, Illinois. There at the Refectory they were treated to a delicious luncheon featuring giant-sized shrimps. Under the direction of ROBERT A. BEAN, Director of the Chicago Zoological Park, ROBERT SNEDIGAR, Curator of Reptiles and Invertebrates, and other members of the staff informal tours were conducted through the grounds.

The evening was devoted to social activities at a "smoker" held in the Central Hall of the Shedd Aquarium. While everyone was imbibing or eating suitable refreshments the 1960 edition of *Dopeia* was placed on sale.

EVENTS OF SUNDAY, JUNE 19

The herpetologists assembled to participate in a symposium entitled "Amphibian and Reptile Populations under Diverse General Environmental Conditions." The panel consisted of DR. KENNETH S. NORRIS, Chairman, and DRS. W. FRANK BLAIR, J. SHERMAN BLEAKNEY, WALTER C. BROWN, and HENRY S. FITCH. DR. BLEAKNEY'S paper dealt in particular with the limiting effects of the short growing season on amphibian

distribution in northern Canada. Because DR. BROWN had injured his vocal cords, his paper was read by DR. JAMES A. PETERS. It was mainly devoted to the results of intensive sampling of herpetofaunal populations in the tropical montane forests of the Philippines, where the atmosphere is almost constantly saturated. In contrast, DR. BLAIR concentrated his address on the relationships between rainfall and breeding cycles of frogs in the arid southern United States. In speaking on his studies in the more temperate forest-edge zone in the central United States, DR. FITCH selected four species of snakes to illustrate in detail the range of ecological adaptations in a single group in a single place.

The ichthyologists meanwhile, under the chairmanship of DR. CARL L. HUBBS, listened to the following papers:

The Adrianichthyidae, a Reappraisal of its Ordinal Affiliations. Donn Eric Rosen, University of Florida.

Generic and Specific Relationships of Atlantic and Pacific Tunas. Robert H. Gibbs, Jr., Boston University.

Systematics of Garfishes. Royal D. Suttkus, Tulane University.

Cranial Nerve Evidence for the Relationships of Some Percomorph Fishes. Warren C. Freihofer, Stanford University.

Osteology and Phylogeny of Oviparous Cyprinodont Fishes. Ram P. Sethi, Brown University.

The Subocular Shelf of Fishes. C. Lavett Smith and Reeve M. Bailey, University of Michigan.

Geographic Variation of the Flathead Chub, *Hybopsis gracilis*. Leonard J. Olund and Frank B. Cross, University of Kansas. (Presented by Cross)

Stream Capture and the Distribution of the Percid Fish *Etheostoma sagitta*. R. M. Bailey and R. A. Kuehne, University of Michigan and University of Kentucky.

The Identification of Larval *Perca flavescens* and *Stizostedion vitreum* with Reference to Chromatophore Variability. Carroll R. Norden, Southwestern Louisiana Institute.

Systematic Relationships of the Cyprinid Fishes, *Notropis cornutus* and *Notropis chrysocephalus*. Carter R. Gilbert, U.S. National Museum.

During the afternoon DR. GEORGE A. MOORE presided at the ichthyological sessions during which the following papers were given:

Some Relationships between Parasitic Isopods and Marine Fishes. Gilbert L. Voss and C. Richard Robins, University of Miami.

Geographical Variation in the Size of Eel Elvers, *Anguilla rostrata*. Vadim D. Vladykov, University of Ottawa.

Deepwater Butterflyfishes. Carl L. Hubbs, Scripps Institution of Oceanography.

The Fish Fauna of Clipperton Island. Boyd W. Walker, University of California at Los Angeles.

Opportunities for Ichthyological Research in National Parks. O. L. Wallis, U. S. National Park Service, Washington, D. C.

Sound Discrimination in Two Species of *Notropis*. Exalton A. Delco., Jr., University of Texas.

Maleness in *Mollienesia formosa*. Clark Hubbs, University of Texas.

Food Selection by Fishes Invading a Salt Marsh: from Flooding through Progress of a Mosquito Brood. Robert W. Harrington, Jr., Florida State Board of Health, Vero Beach.

Some Marine Fishes with Anatomical Anomalies and Injuries. Gordon Gunter and J. W. Ward, Gulf Coast Research Laboratory and University of Mississippi Medical Center.

High Selectivity of Sampling Gear in a Fish Faunal Study in Alaska. Karl F. Lagler, University of Michigan.

Fecundity of Southeastern Alaska Chum Salmon. Howard S. Sears, U. S. Bureau of Commercial Fisheries, Juneau.

Fishery Survey in Arctic Canada. W. B. Scott, Royal Ontario Museum.

Concurrently, the herpetologists, with DR. DAVID L. JAMESON presiding, listened to the following papers:

Differentiation in the Mating Calls of the Toads Allied to *Bufo debilis*. Charles M. Bogert, American Museum of Natural History.

Osteological Variation and Relationships of *Anolis*. Richard Etheridge, University of Southern California.

Species Recognition in Sceloporine Lizards. Don Hunsacker II, University of Texas.

Functional Morphology of the Swallowing Mechanism in a Generalized Colubrid, *Elaphe obsoleta quadrivittata*. R. Gerard Albright, University of Detroit.

The Effect of Temperature on Development in Snakes. Wade Fox and Charles Gordon, Louisiana State University School of Medicine.

Development and Pattern of Replacement of Frog Teeth. Coleman J. Goin and Martha Hester, University of Florida. (Presented by Hester)

The Rio Grande Channel of Trans-Pecos Texas—a Major East-West Dispersal Pathway. Ralph W. Axtell, Sul Ross State College.

Heritability of Geographic and Individual Variation of Trunk Segmentation in the Red-backed Salamander, *Plethodon cinereus*. Richard Highton, University of Maryland.

Reproductive Structure in a Population of the Rattlesnake, *Crotalus atrox*. Donald W. Tinkle, Texas Technological College.

Notes on the Herpetofauna Near Karachi, Pakistan. Sherman A. Minton, Jr. and Madge R. Minton, Basic Medical Sciences Institute, Karachi, Pakistan.

The Use of Nembutal in the Study of Natural Populations of Poisonous Snakes. Harold E. Laughlin, Welder Wildlife Foundation.

Report on the Galápagos Tortoises in American Zoos in January, 1960. René E. Honegger, Zoological Society of Philadelphia.

During the early evening members and guests assembled in the cafeteria at the Chicago Natural History Museum for the annual banquet. After the meal was over, everyone adjourned to the ground floor lecture hall, where, under the chairmanship of President-elect GEORGE A. MOORE, committee reports were heard as follows:

(a) Stoye Prize Committee for the best student papers in both disciplines, consisting of RUDOLFO RUIBAL, Chairman, CHARLES M. BOGERT, GILES MEAD, and PHILIP W. SMITH. In the absence of the Chairman, the report was presented by DR. SMITH. He stated that because of the paucity of student papers in ichthyology, the committee

had chosen to award only one prize in this subject this year. This, to be considered as a first prize of $25., was given to EXALTON A. DELCO, JR., of the University of Texas.

Prizes in herpetology were awarded as follows: First Prize, C. ROBERT SHOOP, Tulane University, $25. Second Prize, JUDITH HARDY, Adelphi College, $15. Third Prize, DAVID B. WAKE, University of Southern California, $10. For the guidance of the Chairman of the Local Program Committee at future meetings of the Society, the Stoye Prize Committee called attention to the following difficulty: Because there were two concurrent sessions in herpetology on Friday afternoon and because student papers were given in each of the two sessions, it was impossible for the herpetologists among the judges to hear all the papers. The Committee recommended that, if a similar situation should occur in the future, arrangements should be made by the Chairman of the Program Committee to have all the student papers given in the same session. It would also be very helpful if student papers on the printed program could be indicated by the word "student" or in some other fashion.

(b) Resolutions Committee, consisting of CARL L. HUBBS, Chairman, W. FRANK BLAIR, and JOE TIHEN, offered the following resolutions which were adopted unaminously:

"The American Society of Ichthyologists and Herpetologists at the close of its fortieth annual meeting at Chicago, held June 17 through June 19, 1960, expresses profound gratitude to CLIFFORD C. GREGG and staff of the Chicago Natural History Museum, to WALTER H. CHUTE and staff of the Shedd Aquarium, to R. MARLIN PERKINS and staff of the Lincoln Park Zoo, to ROBERT A. BEAN and staff of the Chicago Zoological Park, and to all other organizations and individuals concerned, for the hearty welcome, generous hospitality, and excellent arrangements and facilities.

"Especial thanks go to the hard-working members of the Local Committee: ROBERT F. INGER, GEORGE B. RABB, D. DWIGHT DAVIS, LOREN P. WOODS, MARION GREY, PEARL SONODA, JANET WRIGHT, HYMEN MARX, ROBERT SNEDIGAR, R. MARLIN PERKINS, WILLIAM BRAKER, CLIFFORD H. POPE, and TOM DOLAN; to the efficient projectionists, JAMES BACON and MICHAEL DUEVER; and to all others who have cooperated so effectively in making this large meeting one of the most pleasantly memorable and most successful in the history of our Society.

"Whereas, the vastly increased use of rotenone and other poisons in controlling fish populations, in more and larger bodies of water (including even whole stream systems), that has threatened the continued existence of certain local populations and even some local forms of native fishes,

"Be it therefore resolved, by the American Society of Ichthyologists and Herpetologists, at its fortieth annual meeting, that federal, state, and other authorities, in planning and executing such control measures, be urged to seek in advance the advice of independent zoologists, and to use full caution and restraint, to the end that such populations and forms are not subjected to the danger of extirpation or extreme depletion; and

"Be it further resolved, that copies of this resolution be submitted to appropriate wildlife administrators.

"Whereas, grave consequences would result from legislation preventing experimentation on animals,

"Be it resolved, that the American Society of Ichthyologists and Herpetologists, at its annual meeting in June, 1960, expresses strong opposition to bill S 3570 or any other federal legislation that would withhold federal support for researches involving experiments on live animals, or that would attempt any form of licensing or other regulation of such experimentation.

"Whereas, various alarming measures to prevent the importation of animals for zoological, educational, scientific, and medical purposes have been promoted, and

"Whereas, bill H 10598 proposes measures that would make it possible for appropriate institutions to continue the importation of such animals,

"Be it therefore resolved, by the American Society of Ichthyologists and Herpetologists, at its fortieth annual meeting, that the Society endorses those features of bill H 10598 that would make such importation legal, and that the duly appointed representatives of the Society be authorized to testify to that effect.

"Whereas, the American Society of Ichthyologists and Herpetologists has profited immensely by the effective, genial, and generous administration of Society affairs by the retiring Secretary, ROGER CONANT,

"Be it resolved, by the Society at its fortieth meeting that sincere gratitude be expressed to him for these grand services, and

"Be it further resolved, that the President, Treasurer, Editors, and all other officers and committee members of the Society also be thanked for the time and effort that they have expended on the affairs of the Society."

The group was then treated to a very fine color motion picture film entitled "Marine Biological Research in the Virgin Islands" which

was taken and personally narrated by DR. JOHN E. RANDALL, of the University of Miami.

Subsequent to the close of the meeting the local Committee reported that a total of 206 persons had registered, and of these 86 indicated that they were ichthyologists and 93 that they were herpetologists; six persons stated they were both ichthyologists and herpetologists.

In concluding these minutes the retiring Secretary wishes to express his appreciation for the cooperation that has been extended to him during the past three years by the members, governors, and officers of ASIH. He is especially grateful to the Presidents EDWARD H. TAYLOR, REEVE M. BAILEY, and NORMAN E. HARTWEG, under all of whom he served, and to Treasurer JAMES E. BÖHLKE with whom he was in touch at almost weekly intervals, and whose council and patience were extremely valuable.—ROGER CONANT, Secretary.

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